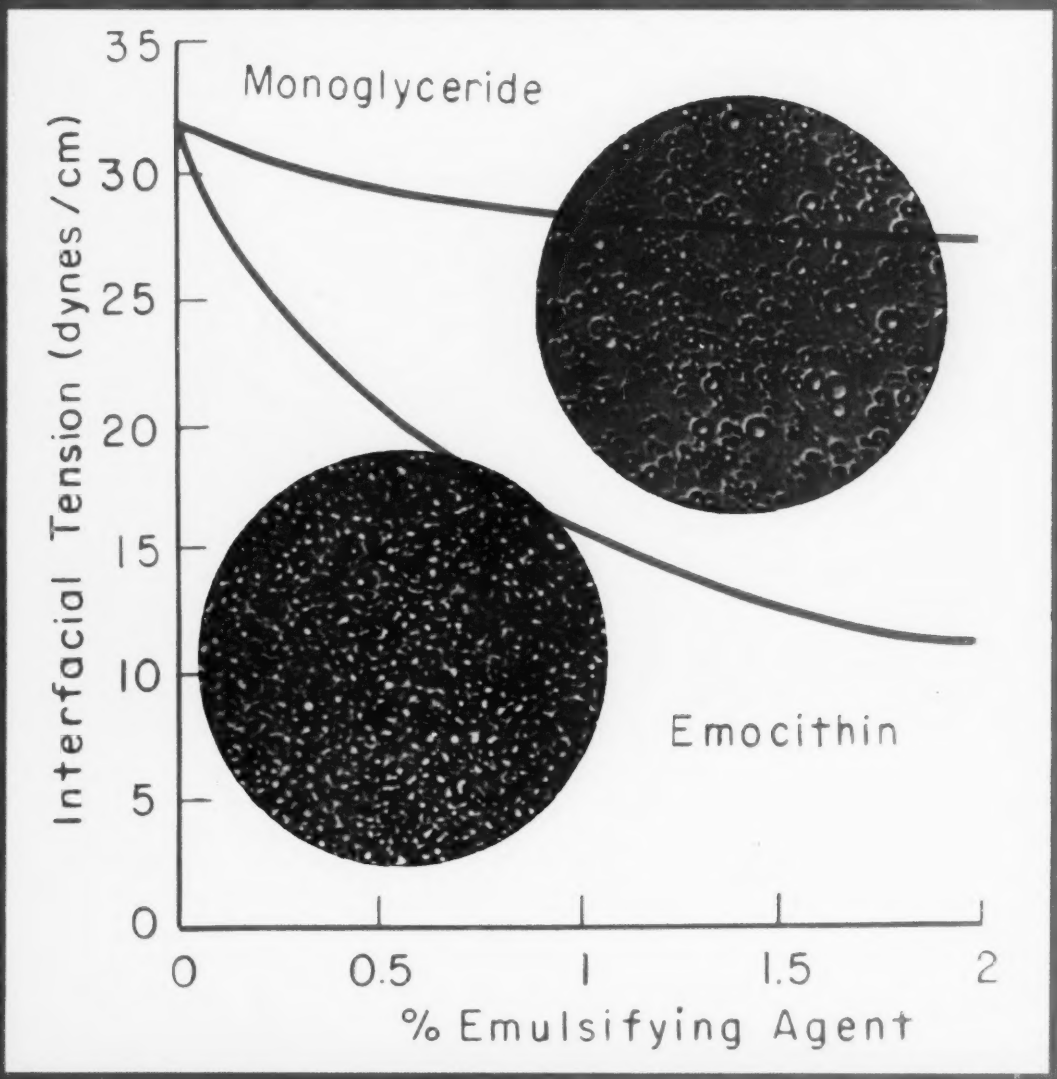
Vol. 13, No. 12 December, 1957

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE



JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

You get automatic foolproof lubrication with LUBRIVAL circulating oil system

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Studies in Centralized Lubrication
No. 207

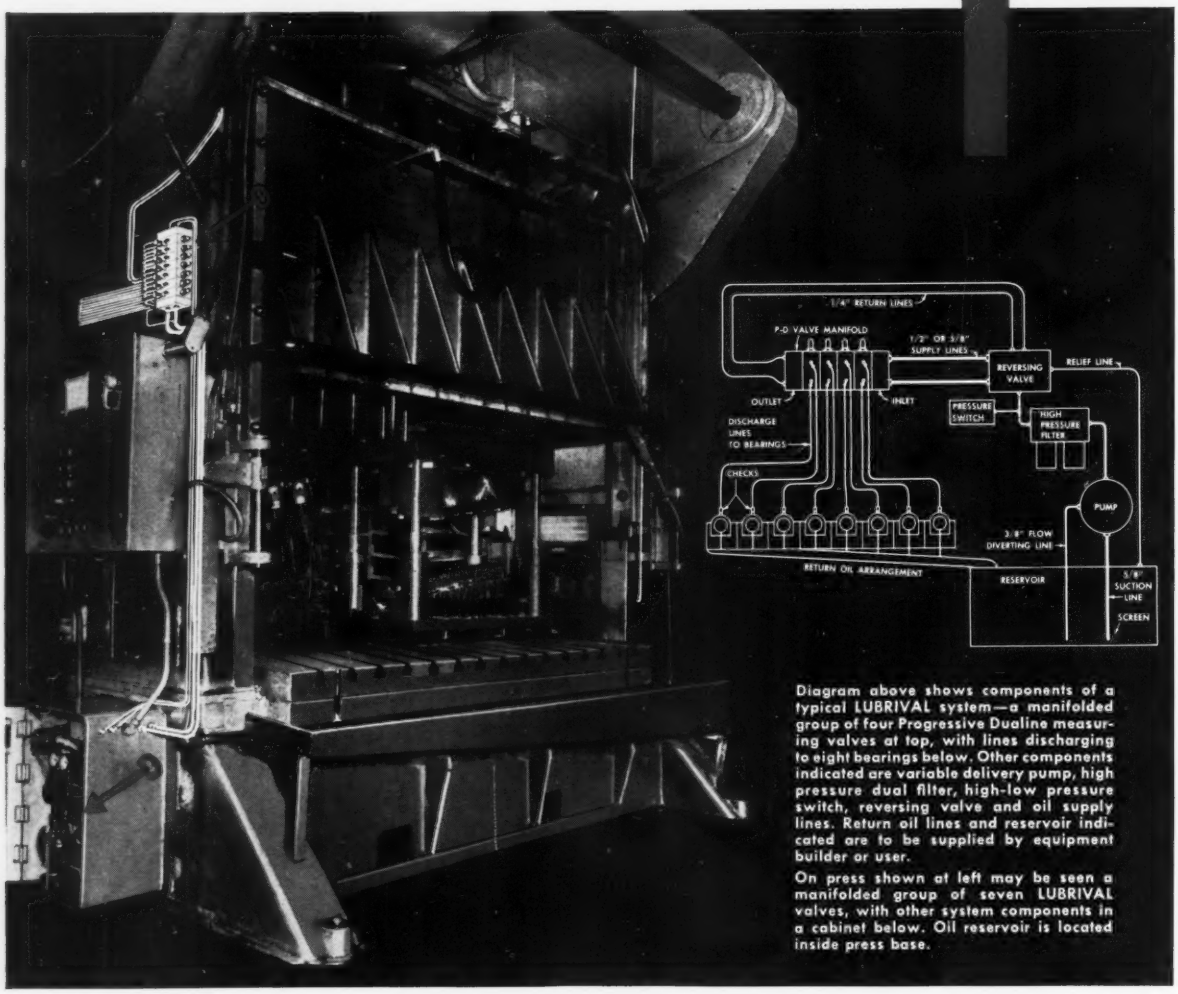

Diagram above shows components of a typical LUBRIVAL system—a manifolded group of four Progressive Dualine measuring valves at top, with lines discharging to eight bearings below. Other components indicated are variable delivery pump, high pressure dual filter, high-low pressure switch, reversing valve and oil supply lines. Return oil lines and reservoir indicated are to be supplied by equipment builder or user.

On press shown at left may be seen a manifolded group of seven LUBRIVAL valves, with other system components in a cabinet below. Oil reservoir is located inside press base.

● The bearings of this 150-ton metal stamping press and others of its type are now protected by LUBRIVAL. This new Farval system for circulating oil is being installed on many varied kinds of machine tools, presses, automated machines, and other equipment calling for circulating oil lubrication.

Employing the famous Dualine principle, LUBRIVAL delivers oil to manifolded measuring valves which feed it under pressure to the bearings. Lubricant is force-fed by positive piston displacement. Flow can be regulated over a range of 10 ounces to one gallon per minute. Valves have individual sight indicators and offer a degree of installation and operational flexibility previously unknown in such devices.

The Farval representative near you will give you all details. Or write for Bulletin 70. The Farval Corporation, 3267 East 80th Street, Cleveland 4, Ohio.

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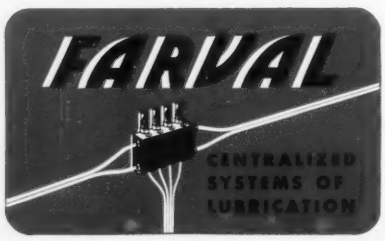
KEYS TO ADEQUATE LUBRICATION—
Wherever you see the familiar Dualine valve manifolds, dual lubricant lines and central pumping station, you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of bearings.



LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

Volume 13, No. 12

December, 1957

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COVER STORY

Emulsifier Serves Many Lube Needs

Through its ability to form unusual thermostable emulsions, a new water-in-oil emulsifier announced by Morningstar, Nicol, Inc., opens new horizons for the lubrication engineer and the lubrication chemist. The product, Emocithin, which already in wide use in Europe, is the development of W. A. Scholten's Chemische Fabrieken, Foxhol, Netherlands, whose products are exclusively distributed in the United States by Morningstar.

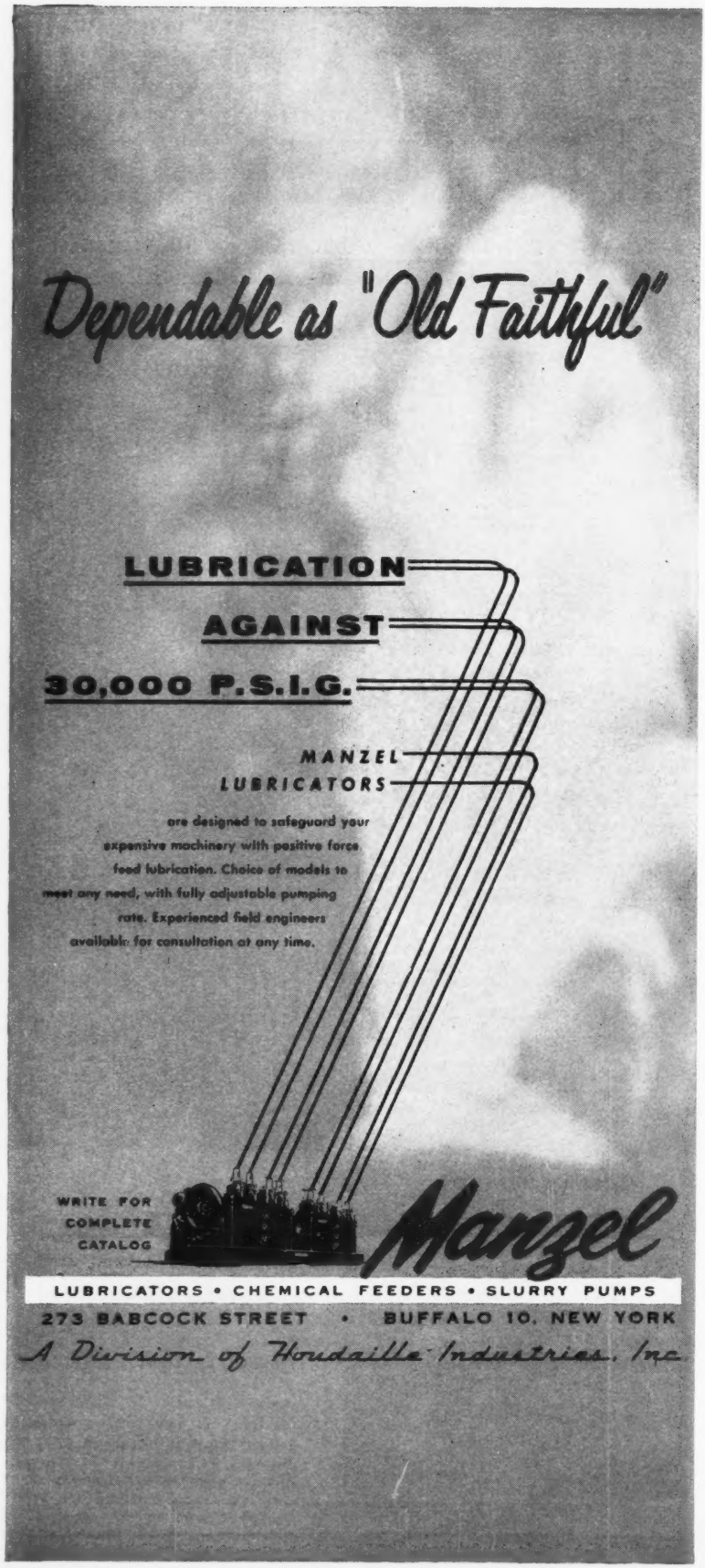
Whereas most emulsifiers are of the O/W type, the new product is exclusively for the preparation of W/O emulsions, where aqueous phases are finely dispersed in continuous oil or fat phases of vegetable, animal, or mineral oils. In contrast to other emulsifiers of the W/O type, such as the mono- or diglycerides of fatty acids, which produce emulsions which are not thermostable, Emocithin produces W/O emulsions which will not separate at temperatures up to 200°F (per ASTM Steam Emulsion Test D 157-36).

Engine and marine lubrication engineers will have a special interest in the product which allows the incorporation of water-soluble corrosion inhibitors in lubricating oils.

Apart from the unique heat stability of the emulsifier, photomicrographs (see cover) show the superior fineness and uniformity of water-in-oil emulsions maintained by 2% Emocithin and a like amount of a frequently employed monoglyceride of a higher fatty acid.

Beyond the specific use possibilities noted above, this new and superior agent for forming stable water-in-oil emulsions should find further utility where: (1) incorporation of well-dispersed water is desired to extend a fat or wax in either bulk or weight, or improve its physical characteristics, (2) it is desired to incorporate in the product salts, dyes, biologicals or other substances which can be dissolved or dispersed in water but not in oil phases, as in the pharmaceutical, food, fuel and lubricating-oil fields, (3) W/O emulsions must withstand elevated temperatures, either in service or under the heat of processing or blending, and (4) an emulsified product would be better developed with a continuous oil phase rather than a continuous water phase.

Morningstar, Nicol, Inc. has technical data available based upon European experience with the product and can suggest amounts and procedures for emulsification processes using it.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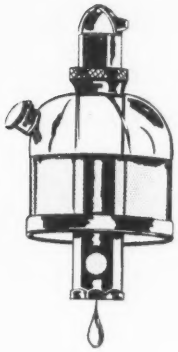


Highlights of Articles Scheduled for Coming Issues!

Vacuum Dehydration of Oils

The presence of water in oil impairs lubricating properties, increases the oxidation rate, and causes development of sludge formation and costly corrosion to equipment. Removal of the water from lubricating oils is both more important and more difficult with modern high-speed high-pressure machinery. A new look at vacuum dehydration techniques indicates that this method may permit the lubrication engineer to select high performance lubricating oils without being limited by the demulsibility characteristic of the lubricant.

The Preparation of Highly Effective Rust Inhibitors by Fractionation of Mahogany Sulfonates

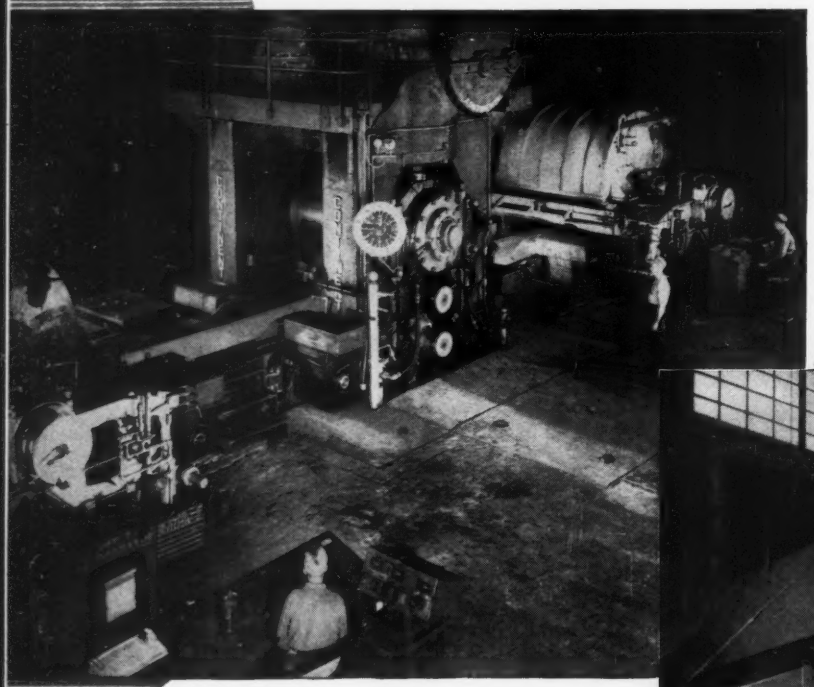
Continuous extraction of solutions of commercial mahogany sulfonates in a 50 percent isopropal alcohol with petroleum ether was employed to prepare some very effective rust inhibitors. Equivalent weight and rust-preventive effectiveness of the fractions were determined; rust preventive effectiveness of the fraction of the highest equivalent weight was three times that of the original material. According to infrared measurements the fractions are similar and have a structure of an alkylated benzene sulfonate.

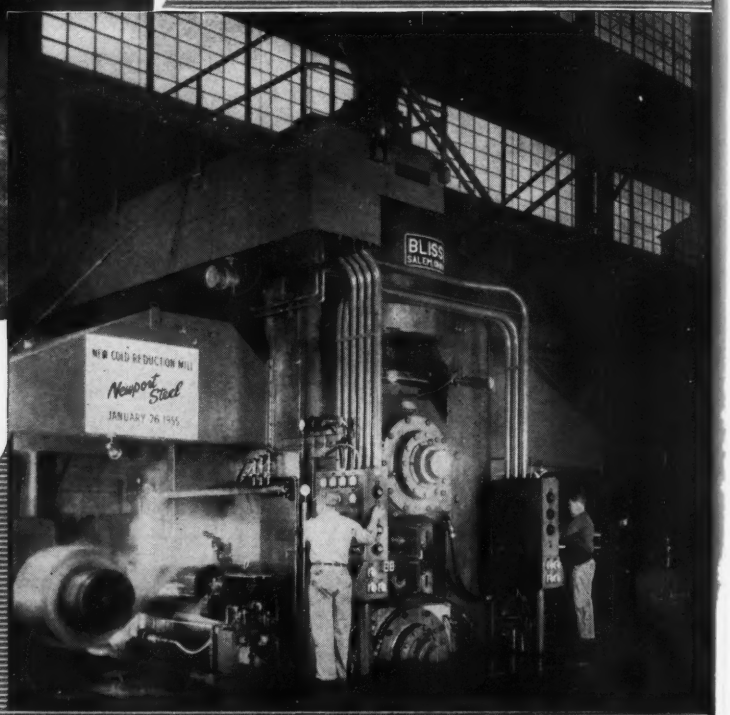
Determination of Grease Consistency Using an Automatic Worker Viscometer

Grease consistency, or resistance to flow, is one of the properties of major importance to lubricant applications. Resistance to leakage from a bearing and distribution within the bearing are in part determined by consistency. Whereas flow properties of oils are characterized solely by the coefficient of viscosity and independent of shear rate, greases are affected by temperature, shear rate, and amount of working. The author describes an automatic worker-type viscometer for evaluating lubricating grease consistency.

REVERSING MILLS

HOT or COLD





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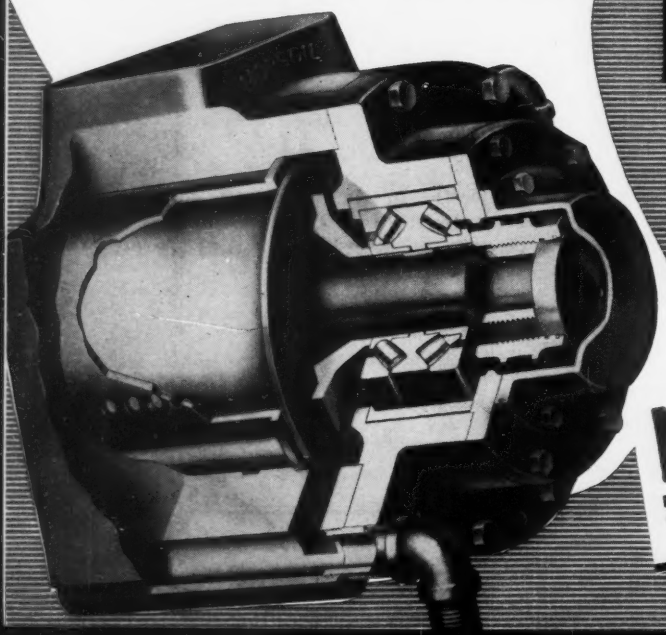

The recent modernization at NEWPORT STEEL CORPORATION, Newport, Kentucky, features a four-high reversing hot mill with Steckel-type furnaces and a four-high cold reduction mill. BOTH mills are equipped with MORGOIL bearings for maximum efficiency.

MB-29

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Announcing the publication of:

"A Survey of Journal Bearing Literature"

by Dudley D. Fuller
Professor, Mechanical Engineering Dept.
Columbia University

Over 2500 references, screened and abstracted from world-wide literature on the subject of journal bearing research, have gone into the preparation of this comprehensive work. The first volume of its kind, it is planned to fill a long-standing need for critical review and evaluation of the extensive journal bearing literature.

The final selection of 563 references was made on the basis of six key criteria:

1. Historical interest.
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3. Key research investigation.
4. Presentation of new and stimulating ideas.
5. Example of design and application.
6. Installation and maintenance recommendations.

In preparation of the abstracts, each has been identified according to the nature of the original work: theoretical, experimental, or based on practice and experience. They outline the scope, conclusions, and general significance of material covered. In addition, a 100 page report and history of the subject, beginning with classical theory and continuing through current research in gas-lubricated bearings, is included.

The result of an eight-year co-operative journal bearing research project initiated by the ASLE Research Advisory Committee, "A Survey of Journal Bearing Research" is the definitive work in the field. It offers the design, operating and applications engineer concerned with this important field his first practical opportunity to thoroughly appraise the voluminous literature on the subject, until now largely scattered and unevaluated.

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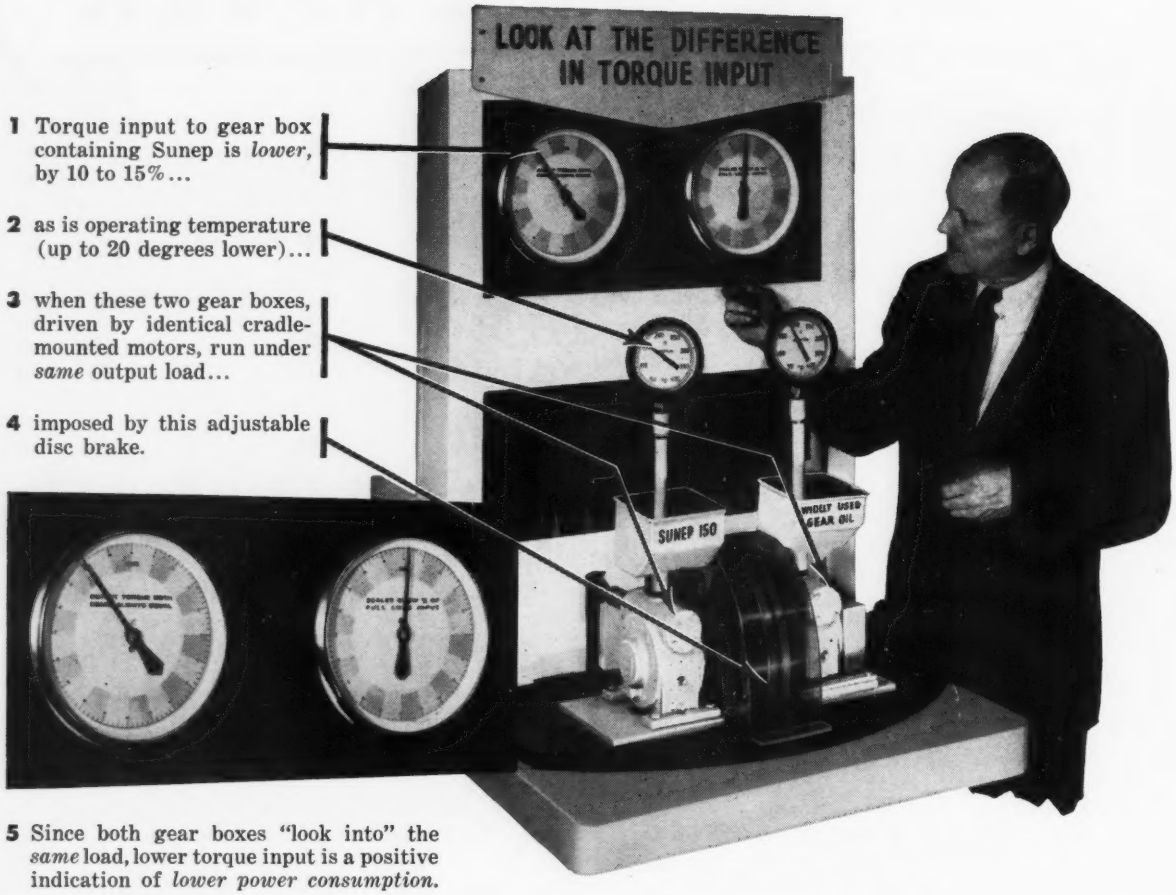
LOOK AT THE DIFFERENCE IN TORQUE INPUT
1 Torque input to gear box containing Sunep is *lower*, by 10 to 15%...
2 as is operating temperature (up to 20 degrees lower)...
3 when these two gear boxes, driven by identical cradle-mounted motors, run under *same* output load...
4 imposed by this adjustable disc brake.
SUNEP 150
WIDELY USED GEAR OIL
5 Since both gear boxes "look into" the *same* load, lower torque input is a positive indication of *lower power consumption.*

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Product Literature

E-P LUBRICANTS BROCHURE —

The Brooks Oil Co. of Cleveland, Ohio now has available a 16-page brochure describing a wide range of tough lubrication jobs of industry and explaining the use of the company's E-P products in solving severe applications. Products are detailed as to type and application. Modern facilities and laboratories are illustrated and described and the continuing research program carried on throughout the company's 80-year history is discussed. For your copy of "Brooks E-P Lubricants" write Brooks Oil Co., 3304 E. 87th St., Cleveland, Ohio.

TEFLON FACILITIES FOLDER —

A folder showing facilities for custom-machining Teflon parts is available from the Plastics Products Sales Division of Raybestos-Manhattan, Inc., Manheim, Pa. The two-color publication displays the assortment of types of Teflon components the division makes and states the tolerances that can be held on these parts.

GUIDE TO CARBIDE PRODUCTS AND SERVICES

The 1958 "Physical Properties" booklet has just been issued. The 28-page booklet, a guide to Carbide's products and services, presents the latest physical property data on more than 350 organic chemicals with an alphabetical index. Fifty new chemicals introduced by Carbide since the previous edition are featured. Viscosity index improver D and Crag Sevin experimental herbicide are two of the new products described in the section on chemicals for special applications. Copies of booklet F-6136 are available from Union Carbide Chemicals Co., E. 42nd St., New York 17, N. Y.

GRINDING OPERATIONS DESCRIBED

"Tool Room Grinding of Alloy, High-Speed and Die Steels," a 24-page brochure, is now available. Designed as a single source book on grinding for tool-room men, the booklet covers 22 areas in the field with short factual copy, pictures, and charts. Quick reference charts are included on "grinding operations" and "grindability of steels in the tool room." The publication is available on request from Advertising Distribution Section, The Carborundum Co., P.O. Box 477, Niagara Falls, N. Y.

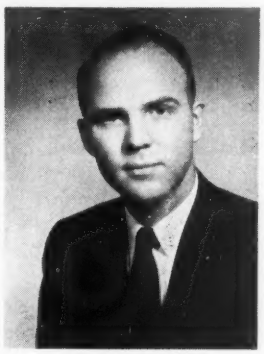
COLOR CONVERSION AID —

A color standards comparison chart is being offered by Armour and Company Chemical Division as an aid in quickly and accurately converting product color readings to a familiar scale. The chart, developed over a period of four years of testing, operates much as a slide rule and gives instant comparisons between five commonly used scales. Reading from left to right on the chart, the scales are Gardner 1933, American Public Health Association, National Petroleum Association, American Society for Testing Material, American Oil Chemists Society Fat Analysis Committee and the Lovibond, both 1 inch and 5¼ inch. On the back of the chart is an indicator for easy identification of Armour fatty acids by name, composition and specifications. Copies of the chart are available on request to Armour and Company Chemical Division, 1355 W. 31st St., Chicago 9, Ill.

Personals

Jeremiah J. Sullivan, Jr. has been named Philadelphia territory sales engineer for Taylor Fibre Co. of Norristown, Pa., manufacturers of vulcanized fibre and laminated plastics. Mr. Sullivan was formerly a salesman for Crosland Equipment Co. of Philadelphia.

Philip J. Berg has been named sales manager of Dravo Corp.'s engineering and construction department, Machinery Division.



PHILIP J. BERG

Parker Aircraft Co., subsidiary of Parker-Hannifin Corp., has assigned Boyce M. Hill to the position of sales manager of the company's Hydraulic Division. Mr. Hill will be responsible for coordinating engineering-management functions with those of the field sales staff.

Alfred C. Webber, research physicist at Du Pont's polychemicals department, has been advanced to the rank of senior supervisor. In his new position, Mr. Webber will continue his work in the field of physical measurements on polymers and plastics. Also at Du Pont, Chemist Dr. A. J. Gordon Allan has been promoted to research associate in which position he will continue his research studies on surface properties of polymers.

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BALL BEARING LUBRIPLATE . . . a most effective grease type lubricant that also protects ball and roller bearings against rust and corrosion. Highly recommended for speeds up to 5,000 RPM and temperatures up to 300° F.

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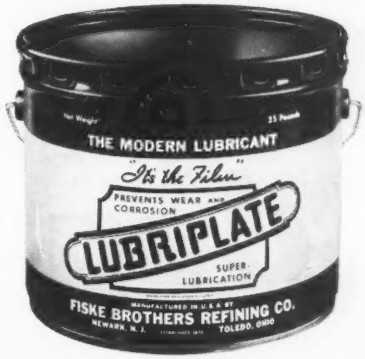

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Plant Maintenance Show Is Scheduled for Chicago

CHICAGO—The annual Plant Maintenance and Engineering Show, to be held here Jan. 27-30, will open with a conference featuring 66 speakers representing a broad cross section of engineering opinion. 425 companies will exhibit at the show itself, which is returning to Chicago for the first time in three years.

Of interest to the lubrication engineer should be the following sessions: Monday, Jan. 27:

"MAINTENANCE IN SMALL PLANTS (Up to 50 Maintenance Employees"—*Moderator:* H. D. Sprenger, maintenance engineer, American Blower division, American Radiator & Standard Sanitary Co., Columbus, O. *Panel:* Svante Eikrem, plant engineer, Hyster Co., Portland, Ore.; Howard Leadbeater, plant engineer, American Pulley Co., Philadelphia; C. H. Pedersen, project engineer, Superior Tube Co., Norristown, Pa.; Homer A. Smith, plant engineer, Diamond Alkali Co., Newark, N. J.; James M. Weeks, plant engineer, Proto Tool division, Pendleton Tool Industries, Inc., Los Angeles.

"MAINTENANCE IN METAL-WORKING PLANTS" — *Discussion Leader:* Otto J. Seidl, plant engineer, East Chicago division, Combustion Engineering, Inc., East Chicago, Ind.

"MAINTENANCE IN RESEARCH AND DEVELOPMENT LABORATORIES" — *Discussion Leader:* George Walter Lees, Jr., plant engineer, Murray Hill Laboratory, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Tuesday, Jan. 28:

"UPKEEP OF ELECTRIC MOTORS"—*Chairman:* R. B. Moore, manager, mining and chemical engineering unit, systems application engineering section, apparatus sales division, General Electric Co., Schenectady. *Speaker:* M. J. Wohlgemuth, assistant to manager, service department, apparatus division, Westinghouse Electric Co., East Pittsburgh, Pa.

"GETTING WORK COOPERATION FROM MAINTENANCE EMPLOYEES" —*Chairman:* Ray A. Nelson, maintenance superintendent, Cliffs Dow Chemical Co., Marquette, Mich. *Speaker:* Wallace E. Fore, plant engineer, Los Angeles division, North American Aviation, Inc., Los Angeles.

"MAINTENANCE IN METAL-FABRICATING PLANTS"—*Discussion Leaders:* George M. Gartner, Jr., field and maintenengineer, General American Transportation Co., Sharon, Pa.; C. J. Nocar, assistant to president, E. F. Hauserman Co., Cleveland.

"MAINTENANCE IN STEEL MILLS"—*Discussion Leader:* A. B. Millman, superintendent of maintenance, Aliquippa Works division, Jones & Laughlin Steel Co., Aliquippa, Pa.

All-Temperature Engine Oil Sought by Military

A single, multi-viscosity engine lubricating oil which will permit vehicles to operate at temperatures ranging all the way from −65 degrees F. to 125 degrees above is urgently needed by the Armed Forces, according to a new publication of the National Inventors Council, U. S. Department of Commerce.

An all-temperature oil would alleviate serious logistics and supply problems in the field, NIC explains.

The call for a new engine oil is one of 387 unsolved scientific problems in "Inventions Wanted by the Armed Forces", published by the Council in cooperation with the Army, Navy, and Air Force.

"The Government hopes that technicians in the petroleum industry may already have the answers to many of these problems," commented John C. Green, director of the Office of Technical Services and the Council's executive director. "If anyone outside the government thinks he knows the right approach to one of these puzzles, we hope he will mail NIC his findings immediately.

Other problems which might be cracked by petroleum specialists include:

A fluorine resistant lubricant or corrosion resistant coating that will perform in the presence of gaseous or liquid fluorine.

Lubricants effective at temperatures as high as 1000 degrees C.

Gelling agents for gasoline that will form gels of firm consistency capable of long term storage under operational conditions. Existing gelling agents form gels which tend to break down after relatively short periods in storage.

Copies of "Inventions Wanted" may be obtained by writing the National Inventors Council, U. S. Department of Commerce, Washington, D. C. Suggested solutions to problems also should be addressed to NIC, which is the Government's official clearinghouse for processes and inventions of potential value to the Armed Forces.

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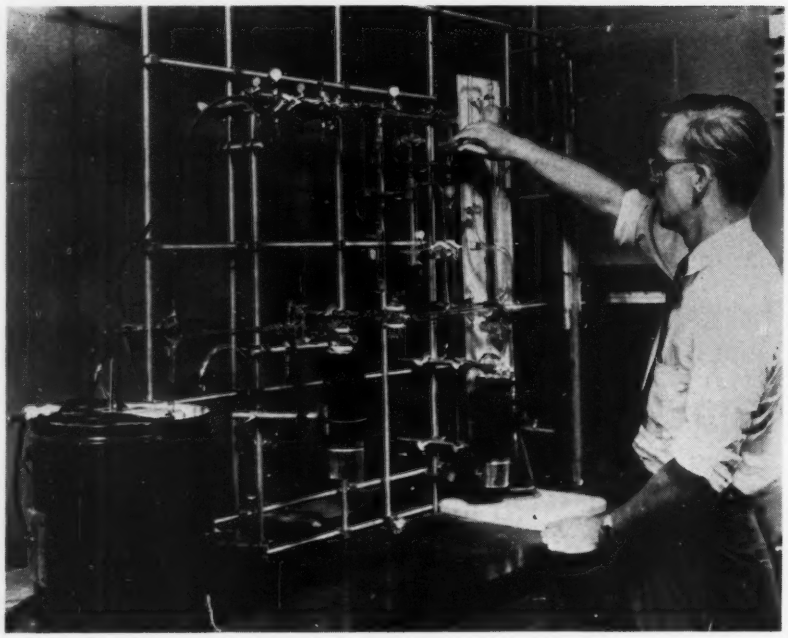


From research come results at General Electric's laboratories as fluids for a new era are tested on specially devised systems.

At left: Norman G. Holdstick, research chemist, tests high temperature fluids on an Isoteniscope, the top of which can be seen protruding from the heating block at left, while a high vacuum system records minute changes in vapor pressures. The equipment can be used for temperatures as high as 1000° F.

Silicone Fluids for the Jet Age

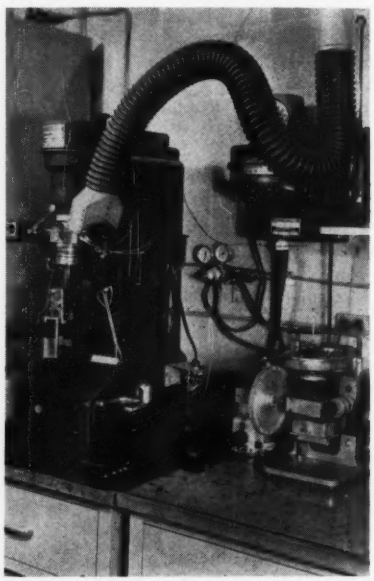
John P. Thomas, Shell Oil Company, Albany, N. Y.

Recently, news of the latest pair of high-temperature silicone fluids was released from the General Electric Research Center at Waterford, N. Y. Designated 81717 and 81644, these new fluids are claimed to provide a closer approach to the related problems of thermal stability and oxidation resistance. 81717 is said to withstand prolonged use over —65 F to plus 575 F while 81644, designed for use in engine and other lubricating systems where exposure to air cannot be controlled, is stable to oxygen under temperatures as high as 510 F. This is some 60 to 80 degrees higher than previously possible with silicone fluids and most other lubricants.

Both 81717, designed primarily as a hydraulic fluid (although it can also be used as a lubricant) and 81644 are related to a third fluid — F-50, the first of the General Electric silicone fluids designated a true lubricant. Prior to its introduction in 1953, silicone fluids were known for their good viscosity stability at high and low temperatures, but they had relatively poor ability to lubricate.

The development of the new fluids provides aircraft engineers greater flexibility than previously possible in the design of hydraulic and engine lubrication systems for aircraft and missiles, primary marketing areas for the new products. Systems designers may now choose a high temperature silicone for lubricity, oxidative stability, or thermal stability, depending on the demands of individual design situations. Since one of the byproducts of silicone fluids under oxidation is highly toxic formaldehyde, both oxidative and thermal stability are essential factors if the fluids are to be used in open systems.

The hydraulic fluid, 81717, was produced under a development contract with the Wright Air Development Center of the U. S. Air Force, while 81644, the engine lubricant, is a product of independent silicone research by G. E. They were improved by modifying the base fluid, F-50, with additives. The engine oil has high lubricity, with correspondingly lesser degrees of oxidation and thermal stability, while the hydraulic fluid ranks highest in thermal stability, with lubricity and viscosity following. The accompanying charts show comparisons with the other substances tested.



Special steel pieces, addition of a strain gauge to record torque readings automatically, high capacity heaters, and inlets and outlets for controlled atmospheres were added to this Shell four-ball wear tester.

QUESTIONS AND ANSWERS

Some of the problems in applying silicone fluids were analyzed in a question and answer session among G. E. scientists associated with their development. Here are some of the more pertinent:

Q. Do these fluids create corrosion problems during storage in containers and equipment?

A. The fluids are ordinarily non-corrosive to metals. However, they do not contain rust preventatives, and therefore exposed metal surfaces may corrode due to water or other vapors.

Q. What types of seals are recommended for systems containing these new fluids?

A. Viton A ring seals have given the most satisfactory service to date. Mechanical seals are also being investigated.

Q. What are the problems of foaming under agitation at high temperatures? Are there chemical or mechanical methods of correcting this problem and, if so, what are their limitations? How do the foaming characteristics of the fluids compare with organic fluids used in engine and hydraulic systems?

A. The silicone fluids foam more than the conventional petroleum fluids presently used but most of the conventional fluids contain foam inhibitors. Some success has been obtained by incorporating special types of anti-foam agents. Thermal shock with a nichrome wire will also supress the foam. Actually, at high temperatures, the foaming problem is reduced, and we have had reports of good lubricity in some systems despite the foaming tendency.

Q. Are there any government specifications covering the use of these silicone fluids?

A. No, but there are some in process.

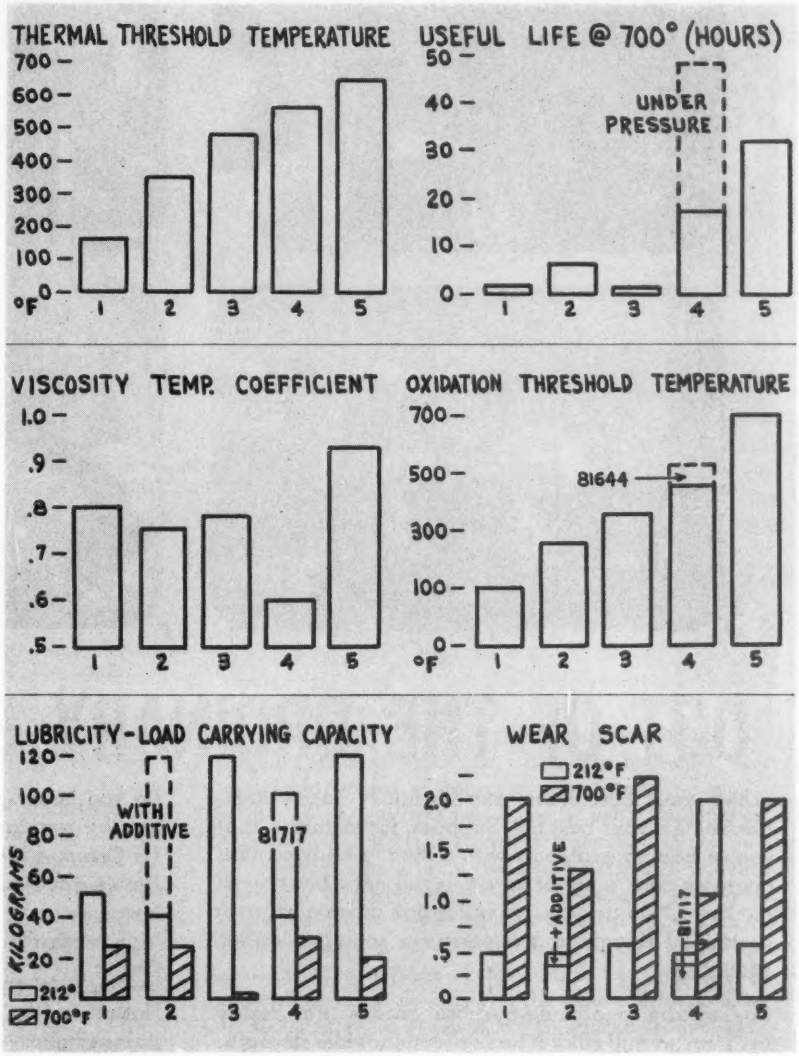
Q. Can the additive used in 81644 to improve the oxidation stability of F-50 be added to 81717 to obtain superior performance?

A. No. A chemical reaction would occur between the additives in 81717 and 81644 which would destroy their effectiveness.

Extreme Environment Testing

G. E. silicone research has developed many new testing techniques and devices for these fluids which

Comparative Performances Of High Temperature Fluids



1. PETROLEUM 2. DIESTER 3. ORTHOSILICATE
4. VERSILUBE 5. CHLORINATED AROMATICS

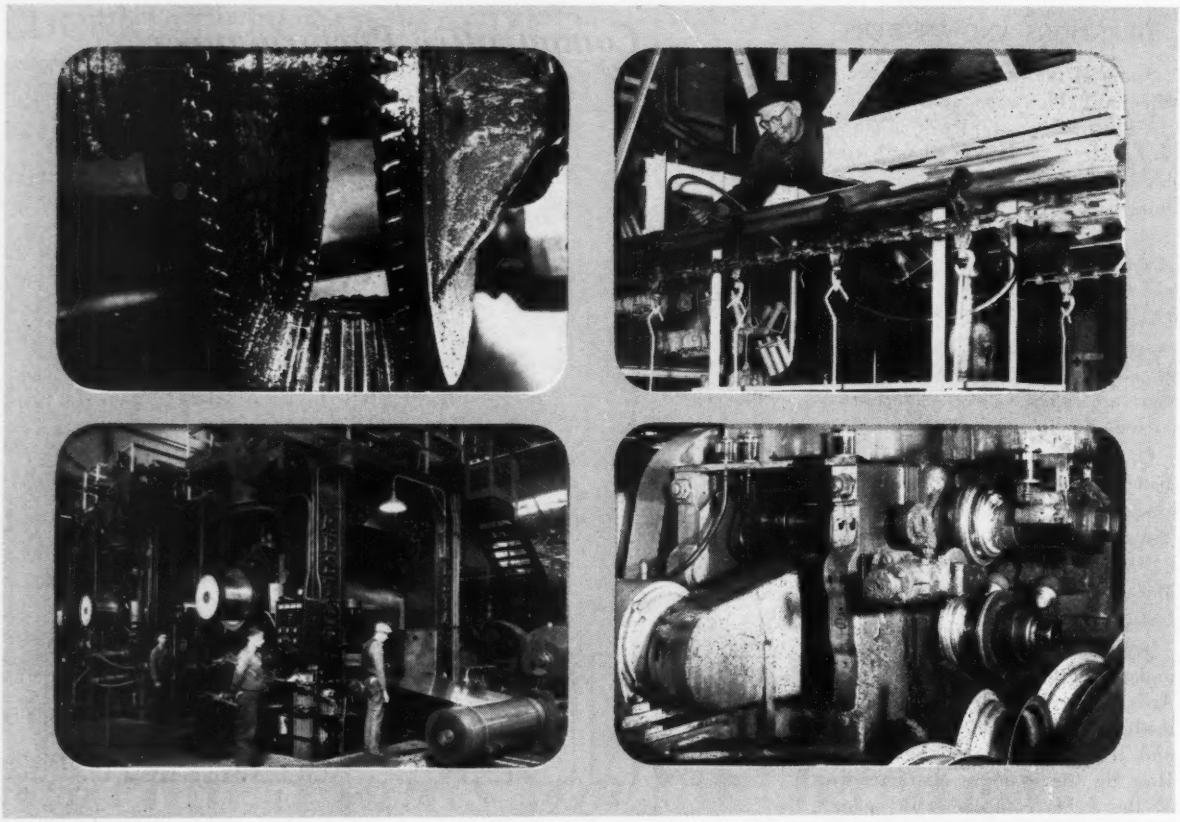
give absolute thermal stability up to 600° F and practical thermal stability up to 700° F. Several of these have been put to use in various study projects by major aircraft industry producers and their suppliers.

Lubricity was explored with a modified Shell 4-Ball and Falex Tester. On the 4-Ball Tester, the mercury contacts had to be changed because of instability at 700° F. The spring for measuring torque was difficult to keep calibrated and strain gauges were substituted. Increment load testing was used to determine the break in the torque curve, which indicates maximum load permissible for fluid lubrication.

Viscosity measurements with the Ostwald Tube required modifications, as well as oxidation tests. Oxidative stability had be be distinguished from thermal stability, and the threshold point between the two determined. Controlled atmosphere of 95 percent nitrogen and 5 percent oxygen was used to simulate high altitude (30,000 to 40,000 feet) conditions.

Test methods used were stated to have good repeatability.

Both new fluids are available commercially.



OUT-OF-THE-ORDINARY LUBRICATION

When you must have extraordinary lubrication, Houghton's your best bet. Suppose, for instance, that you're having problems with a heavy bearing that operates near a water spray, a roll neck bearing or the like. Ordinary grease will break down and wash away, but Houghton greases make such lubrication routine.

Cosmolube is a multi-purpose grease that resists heat, water and cold. It has exceptional film strength. Heavy loads will not change its composition. It can be used with any conventional greasing equipment. Requires few applications, little attention even under heaviest service.

Is there a set of open gears in your plant that seems to eat grease as fast as you can put it on? Try *TENAC. Tenac* is a unique grease for open gears and cables. It sprays on cold, then sets tight. It won't shed, chip, or flake off. The longer it's under a load, the tighter it clings. Resists moisture and high gear speeds that no other grease can.

Do you have an oven conveyor that defies lubrication by regular methods? Three types of Houghton *Hi-Temp* oils cover temperatures up to 1,000°F. Here's ideal, clean, dependable lubrication that keeps wear to a minimum under the most difficult high temperature conditions.

Do you want open bearings to take less oil, less often? Houghton *Sta-Put* oils and greases do just what their name implies—they "stay put". These specially compounded lubricants provide maximum adhesion and cohesion without latex or other non-lubricating additives.

Get the full story of Houghton's whole family of amazing lubricants. Call the Houghton Man—or write E. F. Houghton & Co., 303 West Lehigh Ave., Philadelphia 33, Pa.

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Ready to give you on-the-job service . . .

Lube Lines

by A. F. Brewer*

RUST PREVENTION

Premium grade lubricants today, especially those products which are designed for service in circulating oiling systems for steam turbines, steel rolling mills or paper machines, hydraulic operations or precision ball and roller bearings, function as rust preventives as well as lubricants. The advisability of including rust inhibitors in lubricants of this nature is obvious: moisture, sometimes to a considerable extent, is present in the lubricating system being circulated in contact with the operating parts either as free water or entrained with the lubricant.

Straight mineral oils will function as rust preventives where there is rapid oil circulation and where the probable amount of water present is low or can be controlled by removal in the oil reconditioning system. For years steam-turbine bearing systems operated on such oils. The added factor of safety which is gained by using lubricants containing selected rust inhibitors and anti-oxidation additives, however, will reduce managerial worry as to how effectually the reconditioning system is functioning, and will furnish insurance that bearings and gears will probably last longer with less maintenance.

In other words, the use of rust-inhibited lubricants has a direct relation to cost of maintenance and dependability of production.

The objective in the use of any rust-inhibited lubricant is to prevent water from penetrating the oil film. This is accomplished by the improved ability of the lubricant to adhere tenaciously to metallic (steel) surfaces such as those involved in precision ball and roller bearings, gear teeth and steam-turbine rotor shafting.

In considering the economic value of using suitable rust-inhibited lubricants on precision machinery, it is important to realize that it is not so much the visible as the invisible which is harmful. Rust on any exterior steel surface is unsightly. Where it is present on steel sheets or shapes which are to be used in fabricating, it must be removed before final finishing. On the other hand by that time, possibly, the surfaces are badly pitted, to such an extent, perhaps, that the pits will be obvious through the final paint or lacquer coatings.

Invisible rust formations, however, are in reality termite in effect. Usually, they are progressive, and, where they have accumulated to such an extent as to flake off, then they can become a hazard to lubrication by being circulated through bearing clearances or between gear teeth. This is one of the primary causes of abrasive wear. When rusting has occurred directly on anti-friction bearing components or on gear teeth, the subsequent flaking off will result in pitting similar to that which is caused by a corrosive lubricant.

It is virtually impossible to entirely prevent the tendency of an iron or steel surface to rust; this only could be assured by keeping the surfaces absolutely dry. Obviously this is impracticable in the case of operating machinery. Even in humidity-controlled areas there can be sufficient moisture in the air to promote the oxidation reaction which develops rust. On the other hand, condensation of moisture is retarded when the machine (or parts in storage) can be kept warmer than the surrounding air. Treatment with a suitable rust preventive gives added protection of such parts until they are used in machine assembly, when they will automatically receive similar protection if a suitable rust-preventive additive is included in the lubricant.

Rust is a form of iron oxide. As such it is indicated by more or less scaling and discoloration of the surface which is affected. Viz: the types —

Ferrous Oxide (FeO)	Black
Ferric Oxide (Fe_2O_3)	Reddish-brown
Ferric Oxide (Fe_3O_4)	Reddish-black to black

There are two broad types of such additives: (1) Organic acid materials in which the molecules exert preferable wetting ability upon the surfaces of iron or steel. (2) Emulsifiers which can actually absorb a certain amount of water to hold it in suspension in the oil.

Theory varies as to the action of a rust inhibitor. Basically, however, the essential function is to cause a protective film to form on the metal surface, which will be impervious to the electro-chemical action of moisture and air. The strength of this adsorbed or adherent film depends upon the polarity and the ability of the interface to anchor itself to the surface. Interfacial tension enters into the picture because it relates to the spreading ability of the oil-plus-additive mixture. Only a very small amount of a suitable rust inhibitor added to a well refined circulating oil, is required to impart this protection against rusting. Furthermore film thickness seems to be of secondary importance, because a film of only a few molecules in thickness apparently is satisfactory even in service where a considerable excess of water may have to be run over machinery, as in steel rolling for scale blowing, or in the meat packing industry where machines are periodically hosed down with hot water or steam.

Management is not so much concerned with the type of rust-preventive additive in a prospective lubricant, as they are with the performance ability of the finished lubricant. For this reason lubrication engineers have accumulated much data to indicate the protective ability of rust preventive lubricants, not only with respect to type of additive, but also as to the alloy structure and surface finish of steels as used in the assembly of modern precision machinery.

*Consultant, and author of *Basic Lubrication Practice.*

JULIAN KENNEDY'S *importance to steel making must be measured in millions of tons. When he was born, in the little town of Poland, near Youngstown, Ohio, in 1852, blast furnaces produced only a few tons of iron a day. Before he died he had far advanced the techniques by which one of today's big furnaces produces more than 500,000 tons a year.*

Nor was this all. Julian Kennedy showed the steel industry how to break old precedents, increase production and reduce costs in every phase of mill practice. More than 160 inventions, including blowing and reversing engines, hot blast stoves, blast furnace designs, charging devices, blooming mills and manipulators, poured from his mind. Every mill that he entered prospered — and he was connected with most of the important iron and steel plants in this country. No plant that he ever built failed to make a profit and pay for itself within a few years.

Great Names in Steel Making #VII

The two traits that raised Julian Kennedy to greatness are still living in the men who produce steel ever faster and more efficiently.

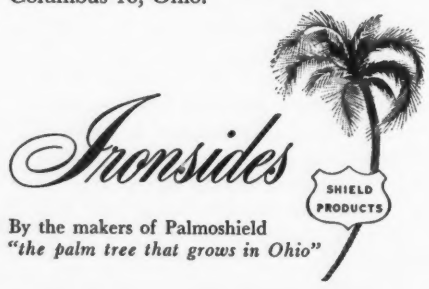
The same impatience with the status quo, and eagerness to apply better products and processes, are seen in the mill superintendents, lubrication engineers and rollers who have recently extended the application of Ironsides' Palmoshield to achieve increased rolling speeds, not only in this country but in overseas mills as well.

This all-American roll lubricant was perfected by Ironsides during the Korean War as the long-sought replacement for imported palm oil. Within six months it was being used or tested in two-thirds of the major mills rolling tin plate. Steel men, appreciating Palmoshield's superior performance, and its availability as a domestic material, have since widened its application to the rolling of light and intermediate gauge sheet, long terne and coating lines as well.

Palmoshield is now proving helpful in the industry's continuing efforts to increase rolling speeds. In test after test "the palm tree that grows in Ohio" has been chosen to lubricate sheet being rolled at sustained speeds in excess of 4,300 fpm.

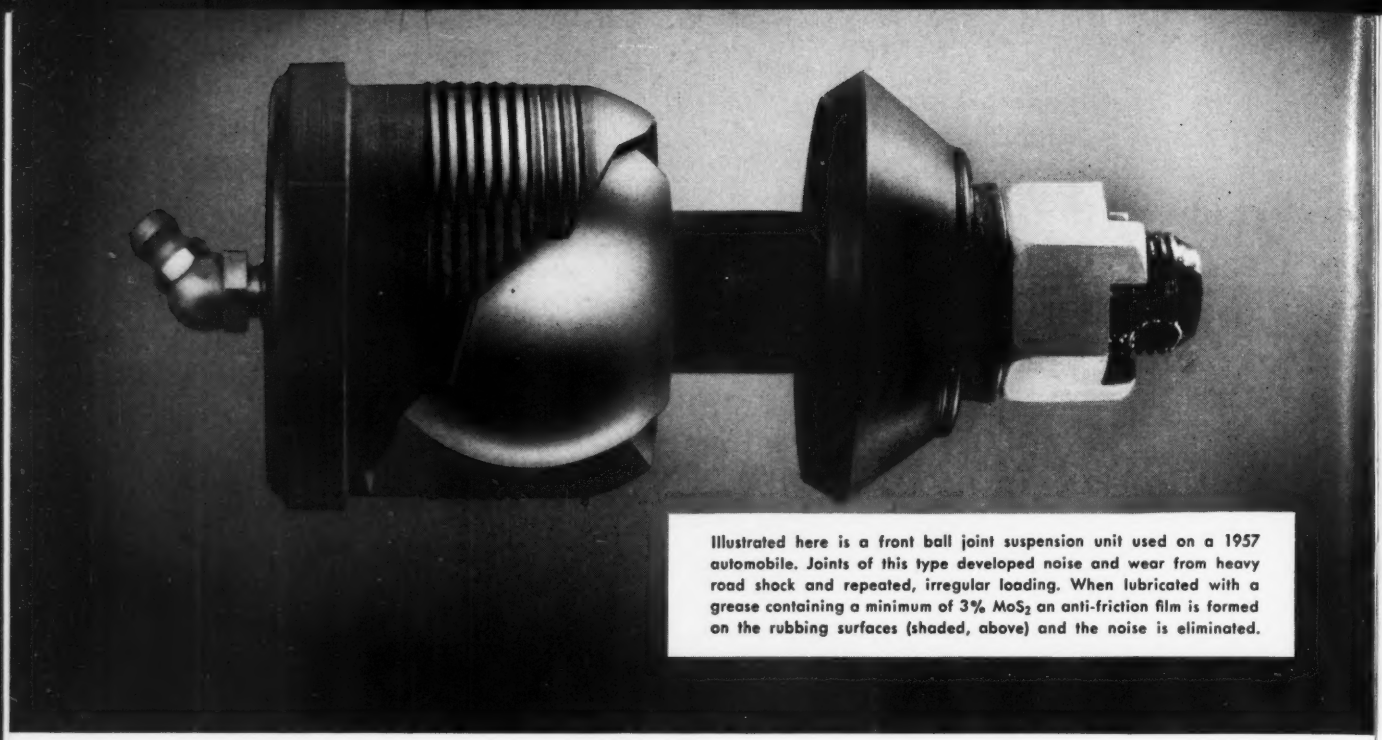
Palmoshield has all the desirable characteristics of palm oil, plus greater uniformity and the immeasurable advantage of being produced entirely of domestic materials, in the heart of the steel district. Chemical control is so close you can specify fatty acid content to ½%. There is no need for stockpiling. You are never dependent on overseas sources or vulnerable to artificial price fluctuations.

Ironsides engineers compound Palmoshield to suit the mill speed, method of application and individual preferences of each user, and guarantee that this "custom tailored" formula will not vary in uniformity thereafter. A letter or phone call will put their years of experience in successful cooperation with America's major rolling mills at your disposal. Address The Ironsides Company, Columbus 16, Ohio.



By the makers of Palmoshield
"the palm tree that grows in Ohio"

Jos. MARGULÉS.



Illustrated here is a front ball joint suspension unit used on a 1957 automobile. Joints of this type developed noise and wear from heavy road shock and repeated, irregular loading. When lubricated with a grease containing a minimum of 3% MoS_2 an anti-friction film is formed on the rubbing surfaces (shaded, above) and the noise is eliminated.

When bearing surfaces are stripped of lubricants by SHOCK LOADING, OSCILLATION or RECIPROCATION . . .

MOLY-SULFIDE additive extends effective lubrication

Serious lubrication problems are often set up by extreme pressures, shock loading, oscillation and certain forms of reciprocating motion. Conventional lubricants may be forced out of the bearing area or wiped off the bearing surface. Then something more than a standard grease is required.

In situations of this kind, grease containing Moly-Sulfide proves its great value. MoS_2 is forced between the rubbing surfaces, adheres to the metal and forms a protective film that prevents galling, welding and fretting. The extent to which MoS_2 sustains lubrication is demonstrated by substantial reduction in wear, and is borne out by field reports from many different industries.

4 specific cases show advantages of MoS_2 for industry

Avoids splitting in steel punching. For example, while punching 5/8" holes in 1/2" thick hot rolled steel it was found that splitting of the plate frequently occurred between two adjacent holes, or toward the edge of the plate. This trouble, a result of heavy shock loading, was eliminated by brushing punches with lubricant containing MoS_2.

Makes excellent break-in lubricant for rocker arms. For break-in runs of engines, one of the major automobile manufacturers uses a supplemental MoS_2 grease on rocker arm pivots. The MoS_2 provides a low-friction film when the base lubricants wipe off under oscillating motion. This prevents galling and scoring of the mating surfaces.

Gives smooth travel to 4-ton grinding head. On a heavy cylindrical grinder the 4-ton head moves on the ways in a jumpy fashion, resulting in damage to the work. Use of a lubricant containing MoS_2 results in smooth, precise travel.

Serves well where lubricant cannot be resupplied. Moly-Sulfide is now widely used for lubricating such hard-to-reach points in automobiles as convertible top mechanisms, power operated windows and seat adjusters. Applied at assembly, the MoS_2 extends lubrication and greatly reduces noise and wear.

Many manufacturers now producing MoS_2 greases

Moly-Sulfide greases are available from many producers today. For a list of the manufacturers of these greases (Lu-2a) – which includes several major oil companies – and for a copy of "Molybdenum Disulfide as a Grease Additive" (Lu-17) write to Department 38, Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

Resolved: Prompt Dues Payment

Since we're all still pretty well imbued with the Christmas spirit of giving, it might be wise to keep a hand in that rather shrunken pocket long enough to remember that January is dues renewal month around ASLE.

Speedy remittance will do away with the unpleasant work of second and third billings, processing and mailing. Each extra invoice, of course, requires extra bookwork on the part of the office staff.

If prompt payment for the year 1958 is not received, it will become necessary to drop a subscriber's name from the list, thus at least temporarily interrupting the sequence of LUBRICATION ENGINEERING issues sent to him. If a drop from membership because of a default in dues payment occurs, a member cannot prorate dues upon reinstatement to full membership. Instead, total payment of the year's dues will be required.

So while that old checkbook is still in plain sight, attach your remittance for dues for the year 1958 to the form which you have already received. All address changes should be duly noted, and the self-mailer portion of the form should be returned for proper posting. The form lists the amount of dues payable for all classes of members — select the proper amount in accordance with your membership classification.

Here's hoping that all our members will be members in good standing for the year 1958 by January 1. And to all *Lubrication Engineering* readers, best wishes for a joyous holiday season and a happy, healthy and prosperous New Year.

J. O. McLean, President

Lubrication Standards For Industrial Equipment

S. O. Kimball, AC Spark Plug Division, General Motors Corp., Flint, Mich.

In much of industry today, the importance of lubrication has not been recognized. It is still regarded as something which must be put up with and is often taken care of by using cheap material and cheap labor.

One reason for this passive attitude toward lubrication is the fact that the results of poor lubrication may continue unnoticed for some time and often are not recognized when the breakdown does occur. Usually, loss of lubrication does not cause immediate stoppage of the machine as does an electrical failure. Even an automobile, as dependent as it is on lubricating oil, does not stop at the first indication of trouble on the oil gage, or even immediately after the loss of all crankcase oil.

With the increase in the use of machines to perform inspection, assembly, loading, unloading and packing operations, and the integration of these machines into production lines, any interruption not only affects just one machine but may mean the shut-down of a whole department. Although lubrication is only one of the factors involved, it is one which has received relatively little attention in the past and therefore can be improved greatly.

PROBLEMS ENCOUNTERED WITHOUT STANDARDIZATION

Many of the maintenance problems which have accompanied the increased mechanization of industrial plants have been eased by the application of the J.I.C. Electrical, Hydraulic & Pneumatic Standards.

With no standards to follow regarding lubrication, the choice of lubrication devices and methods of application has been left up to the industrial equipment manufacturers. The obvious result is that a plant soon acquires a wide variety of different lubrication devices and methods, requiring similar but non-interchangeable servicing equipment. Often, the lubrication is designed to utilize the machine operator to oil moving parts frequently. Such a machine suffers when used in a large plant having centralized lubrication responsibility where an oiler comes around once a day.

Commonly used grease fittings are available in five types, three thread sizes and five drive sizes. Although grease fittings are usually of the same type on a given machine, there may be threaded and drive fittings of several sizes used.

One manufacturer lists fifty-three styles of devices for introducing oil into a bearing. These may be obtained in eighteen different thread sizes and twenty-three different drive sizes. Again, a machine may have several different combinations of style and thread or drive sizes depending on the machine manufacturer's designer's preference.

By the time an industrial plant is equipped to manufacture a product, the maintenance people are faced with the problem of stocking replacement lubrication devices. Usually, the most common types and sizes are kept available for the repairmen to use, and the others are to be ordered as needed. Generally, the final result is that the device which is not readily available is not replaced, and the protection and convenience originally provided is lost.

This condition is complicated further by the lubrication devices provided on machines of foreign manufacture. These also may be of several types and sizes. All are dif-

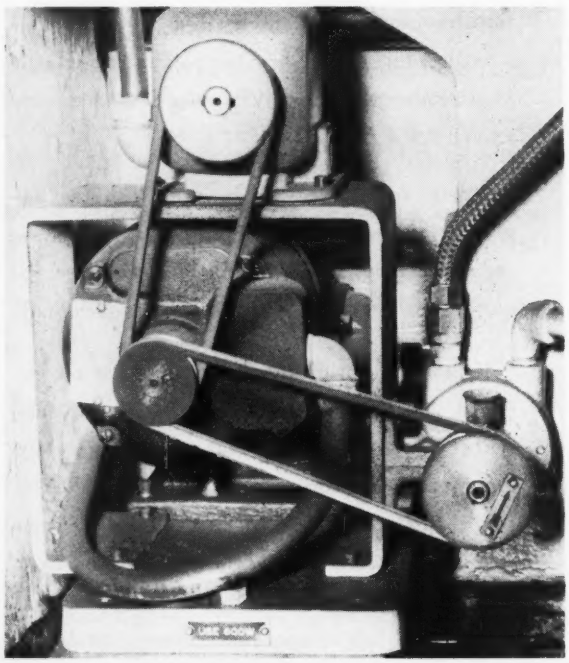


Figure 1. Inaccessible motor reducer.

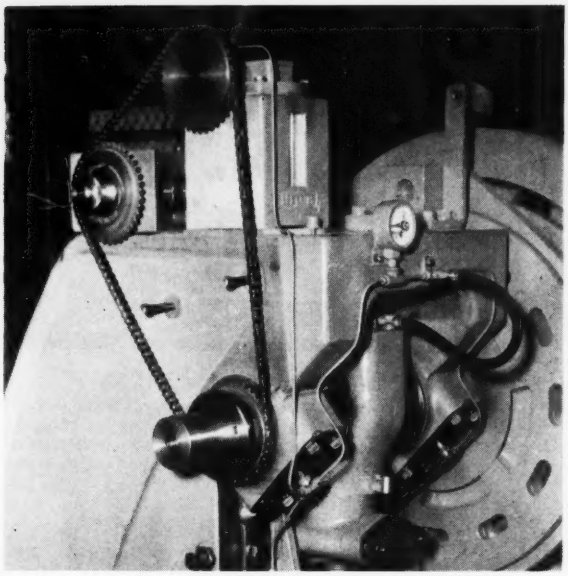


Figure 2. Poorly located lubrication system reservoir.

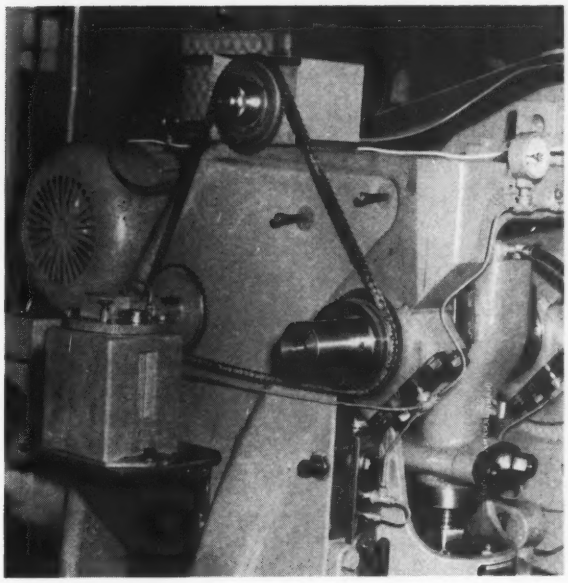


Figure 3. Improved location of lubrication system reservoir.

ferent from domestic devices and usually require special guns or oil cans.

If an oiler carried all the equipment necessary to service all of the different types of oil devices and grease fittings which accumulate in a plant, his truck would be too large to get into congested machine areas and probably too heavy to move without power.

In a modern industrial plant, a machine is purchased to produce work. If it is necessary to stop the machine in order to attend to its lubrication needs, it is not producing work. A man cannot be expected to risk injury to lubricate a machine while it is running and the production department does not like to stop a machine when it is turning out parts. Therefore, either the machine suffers from deferred lubrication or the production schedule suffers from reduced output.

There are many lubrication functions which may require a machine to be shut off, but many of them can be eliminated by forethought on the part of the designer. Let us look at a few examples.

It is impossible to lubricate a grease fitting or fill an oil cup located on a rotating part while in operation; yet many gears, pulleys and flywheels have been designed with the lubricating device on the hub. Very often it would have been quite possible to provide a passage in the shaft to conduct the lubricant from a swivel connection to the bearing. This is now being done on some punch presses.

Air line oilers are necessary on many pieces of industrial equipment today, but these, too, require shut down of the equipment if they cannot be filled without shutting off the air supply.

Occasionally, it is stated that the lubrication of critical machines can be taken care of during the operators' lunch period, but this is not a reliable justification for not providing for safe servicing during operation.

Consider the relatively small department having four packing machines which cannot be stopped for long without creating a pile-up of finished parts from the assembly lines. Lunch period is one-half hour long and each of these machines requires forty minutes to remove the fifteen guards, lubricate the 110 points and replace the guards. A manual grease system reduces the severity of this problem.

Lubrication points which are hidden or inaccessible may be overlooked or bypassed. If such points are serviced, they often cause the oiler to get himself into a hazardous position by climbing upon or reaching into the machine.

Guards and covers are often a part of a machine to improve safety or appearance. However, if it is necessary to remove a number of screws or bolts to get at lubrication points requiring fairly frequent servicing, the chances are that lubrication of such points will be put off until a more convenient time or the guards will not be replaced.

These are some of the situations which occur in a large plant that may sound improbable. Now let us look at a few examples which will illustrate some of the problems confronting the people who must lubricate the equipment in an industrial plant.

Figure 1 shows what an oiler sees when he opens a door to service the coolant pump and motor reducer on a gear machine. The grease cup on the pump may be suitable in many instances, but it requires more time to service than does a grease fitting. Also, there is always the possibility of getting dirt into the grease. As can be seen, the gear reducer cannot be checked, filled or drained and refilled without being removed. This would require several hours during which the machine could produce no gears.

Incidentally, the door for this compartment is hinged and fastened with one screw. The hinge assures the door will not be left off and probably would be closed by anyone finding it open. The single screw for securing the door could be improved only by using a catch or latch which does not require a hand tool for releasing it.

Figure 2 illustrates the installation of an automatic oiling system on a punch press. However, the advantages of the system are partially offset by the location of the oil reservoir. The filler opening was eighty-three inches

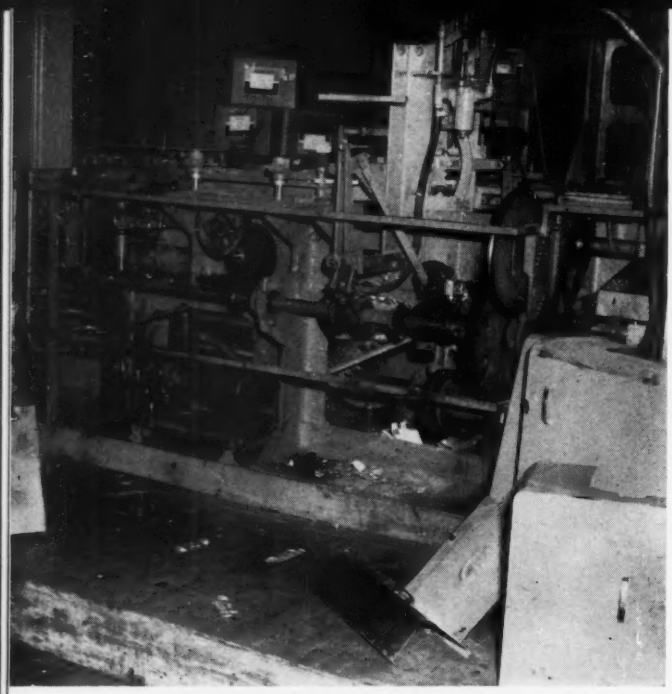


Figure 4. Packing machine with individual point lubrication.

above the floor and behind the chain guard. Therefore, for the safety of the oiler, the press should be stopped while he climbs up to fill the reservoir.

Figure 3 shows how an improvised relocation of the unit improved accessibility by lowering the filler to a point sixty-eight inches above the floor and placing it in front of the chain guard. Here the reservoir can be safely filled while the press is running.

Figure 4 shows a portion of a packing machine having 110 lubrication points to be serviced. To the left and right are seven of the fifteen guards which must be removed to gain access to the fittings.

Figure 5 reveals the same part of the same model packing machine as in Figure 4. In this case a manual grease system has been added to lubricate 80 points. Now these machines can be serviced in 10 minutes time, and only five guards must be removed. The machine must be stopped for only five minutes in order to oil parts which could not be included in the grease system.

The machine in Figure 6 is a large transfer type press of which the upper part is shown. To the right and left on the crown can be seen the drive for the various parts of the feed mechanism, and just above each of the two air valves is an air line lubricator. In this case, the press must be stopped while the oiler climbs to the second level of the catwalk to grease 10 fittings and to check and fill the air line lubricators. There is a manual grease system on the press which should have been extended to include these fittings.

ADVANTAGES OF STANDARDIZED LUBRICATION

The preceding discussion has pointed out and illustrated some of the conditions confronting the lubrication engineer in today's industrial plant. Now let's consider the advantages which could be derived from standardization in the application of lubrication. Although all could be included under the heading of reducing production cost, the resultant benefits can be itemized as follows:

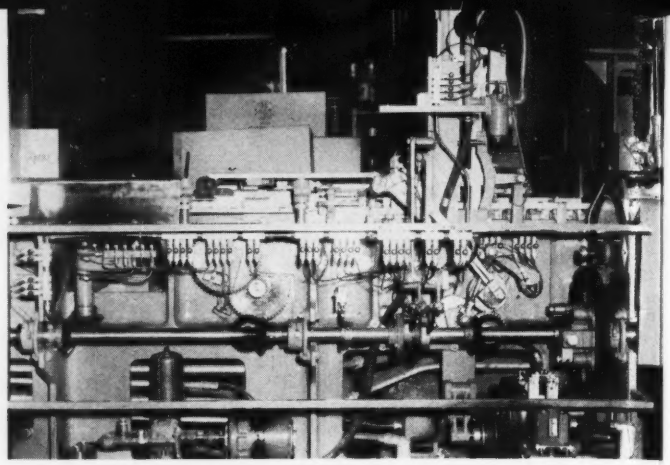


Figure 5. Packing machine with centralized lubrication.

1. Improved safety of personnel
2. Increased machine output
3. Lengthened machine life
4. Better housekeeping
5. Standardized lubrication equipment and methods

The lubrication engineers of a number of divisions within the author's company felt there was a need for lubrication standards to stimulate engineered lubrication. The result is a publication called *Lubrication Standards for Industrial Equipment,* developed by the Shop Lubrication Subcommittee on Lubrication Standards of the author's company and issued in June, 1955.

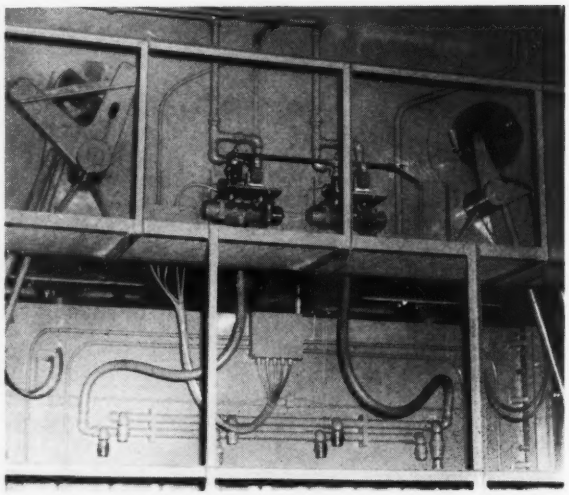


Figure 6. Transfer press with individual point lubrication on the crown.

LUBRICATION STANDARDS

No attempt will be made to discuss these standards in detail, but rather those points which are directly related to realizing the above advantages will be reviewed.

Safety is very important in industry today. It is covered in the standards in one section having three provisions:

1. Lubrication devices shall not be mounted on moving machine elements so as to constitute a hazard to personnel.

(Continued on p. 659)

A Lubrication Engineer Surveys Steel Mill Gearing -- Part II

A. E. Cichelli, Bethlehem Steel Co., Bethlehem, Pa.

Editor's Note: Part I, published in the November issue of *Lubrication Engineering*, treated the general theory of gear design and the use of gears in steel mill operations. This concluding portion treats specific examples of pitting and wear in gears.

18" CONTINUOUS BAR MILL

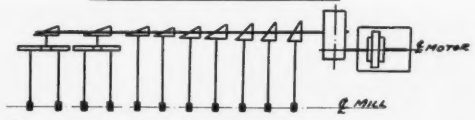
An 18" continuous bar mill having twelve stands and driven by one large motor thru a main line shaft is our first study. In this installation, the main shaft drives the mill stands at right angles to it through various combinations of bevel gears, cross shafts, reduction spur gears and mill pinions. All the drives on this mill are lubricated from one central system and, until recently, with a 600 SSU straight mineral oil. The total horsepower on the mill amounts to 5500, which is divided up among the 12 stands. It is interesting to examine the wear-load criterion on the old bevel gears driving No. 11 and No. 12 stands, on the old spur gears driving No. 1, 2 and 3 stands and the new spur gears driving No. 1, 2 and 3 stands and compare them with their actual performance. Figure 1 summarizes the analysis.

In each instance the Buckingham criterion indicated no wear was to be expected. And yet there was a wide margin between the wear and dynamic loads on the old bevel gears as compared with the spur gears. Because the original spur gears were so badly scored and worn away from a combination of poor lubrication and inadequate metallurgy, (Figs. 2, 3, 4), we conclude first that an EP additive would reduce the scoring, and secondly, the Buckingham criterion was not directly applicable without a higher safety margin. Therefore, a new set was ordered with 18" face vs. 12½" and with higher hardness. (Figs. 5, 6).

Unfortunately, evidence of pitting already has begun on these new gears. Actually the spur pinion hardness was reduced from 240 to 212 Brinell simultaneously with an increase in face length from 12½" to 18" (See Fig. 1). However, the advantages of one change were can-

Fig. 2. 18" Mill No. 3 Spur Pinion (old).

18" CONTINUOUS BILLET MILL



GEAR DESIGNATION		HARDNESS BHN	FACE In.	VEL. fpm	H.P. TRANS.	DYNAMIC LOAD lbs	WEAR CAPACITY
#1 SPUR	OLD	240/185	12.5	232	225	36,230	56,00
	NEW	212/176	18	232	200	32,280	49,00
#2 SPUR	OLD	240/190	12.5	232	300	47,160	54,60
	NEW	212/180	18	232	270	43,850	46,00
#3 SPUR	OLD	197/203	12.5	364	354	38,450	52,50
	NEW	219/185	18	364	318	31,070	55,50
#11 BEVEL		190/190	12.5	1915	815	39,800	73,40
#12 BEVEL		190/190	12.5	2060	815	40,200	64,00

Fig. 1. 18" Continuous Billet Mill Gear Study.

Fig. 3. 18" Mill No. 3 Spur Gear (old).

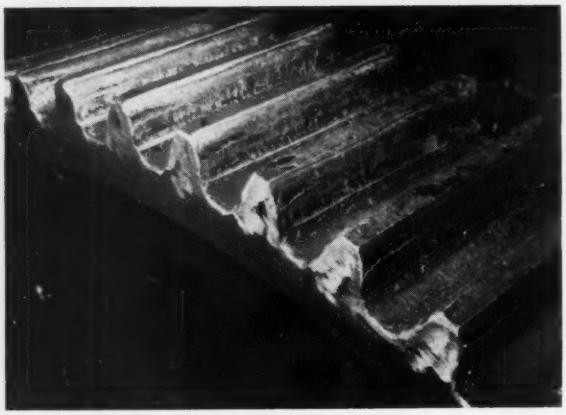


Fig. 4. 18" Mill No. 2 Spur Gear.

celled by the disadvantages of the other, so that the present spur gears and pinions have no greater wear resistance capacity than before. Though tricresyl phosphate has been added to the oil to lessen the scoring, it is evident that these spur gears will eventually fail as did their predecessors.

On the other hand, the bevel gears seem to be unaffected. (Figs. 7, 8). At the time of our spur gear change the original bevel gears were kept in the mill. Note that though straight oils have been in use for a long time, apparently the criterion was reliable in this case. To summarize, Buckingham's method of evaluation indicated the bevel gears had a wide margin of safety built into them—while the spur gears had much less. Though the Buckingham criterion indicated no wear should have taken place in either, it is certainly noteworthy that the method, as applied to steel mill gearing, did establish that the bevel gear rating was higher than the spur and was then borne out in experience.

It is pertinent to note AGMA's criterion most applicable to this problem was attempted on the original spur teeth, actually indicating the teeth were under-designed, unlike the Buckingham criterion. One might ask the relative appropriateness of applying either the AGMA or the Buckingham technique on all steel mill gearing. After this initial study, it was apparent that most steel mill gears fall out of the range of the published AGMA charts

Fig. 5. 18" Mill No. 3 Spur Pinion (new).

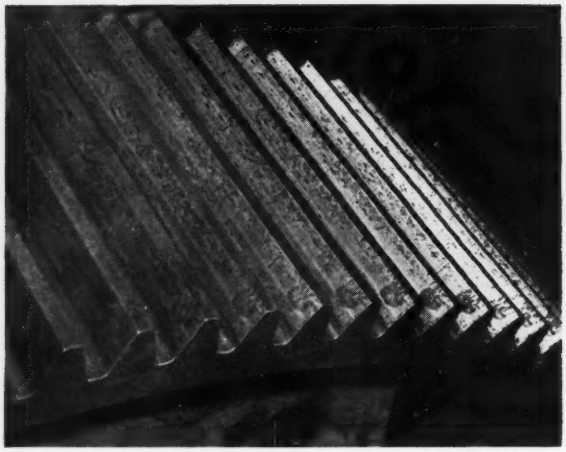


Fig. 6. 18" Mill No. 3 Spur Gear (new).

and that Buckingham's procedure is more easily adaptable. Therefore, all our subsequent studies were made using the latter. This method may ultimately serve to indicate a solution and perhaps only a minor modification will be necessary to adapt it to steel mill gearing.

30" FOUR-STAND BILLET MILL

A 30" four-stand billet mill was recently installed and almost immediately the pinions on the second and fourth stands began to pit. A well recognized lead naphthenate type E—P lubricant had been used from the very beginning, and of course the situation caused alarm. In an effort to track down the trouble, studies of loads were made and photos taken bi-monthly for record purposes. The data shown in Figure 9 give some idea of the load conditions.

Note the wide difference in the dynamic and wear load of No. 2 stand, whereas No. 4 stand's wear-load capacity is closer to its dynamic load. Fig. 10 shows the pitting condition on No. 2. Fig. 11 is a photograph taken two years later. At the beginning there were but a few isolated pits, but after nearly two years the destruction had progressed much further, even up to the addendum. Fig. 12 shows No. 4 stand. Careful examination will reveal failure here has not progressed quite so far. Fig. 13 (in tabulation) shows what effect various design changes

Fig. 7. 18" Mill No. 11 Bevel Gear.

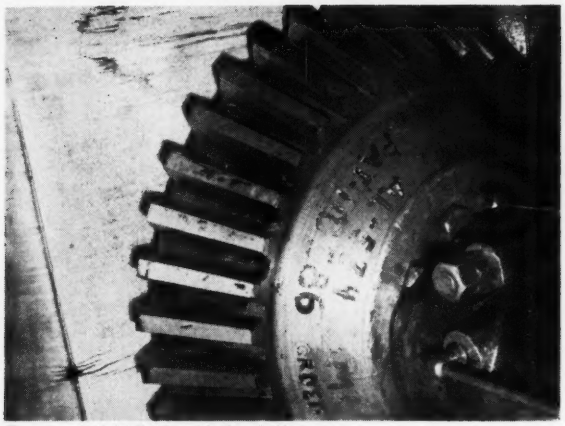
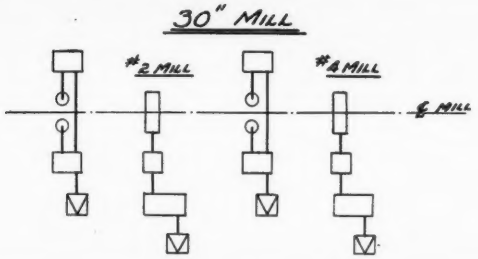


Fig. 8. 18" Mill No. 12 Bevel Gear.



GEAR DESIGNATION	HARDNESS BHN	FACE	VEL. f.p.m.	H.P. TRANS.	DYNAMIC LOAD	WEAR CAPACITY
#2 MILL PINIONS	280	29½"	89.8	483	180,000*	147,200*
#4 MILL PINIONS	280	29½"	137.8	600	147,441*	147,200*
NEW #2 PINION	280	41½"	89.8	483	180,000*	207,000*

Fig. 9. 30" Mill Pinion Study.

Fig. 10. 30" Mill No. 2 Pinion—1954.

Fig. 11. 30" Mill No. 2 Pinion—1956.

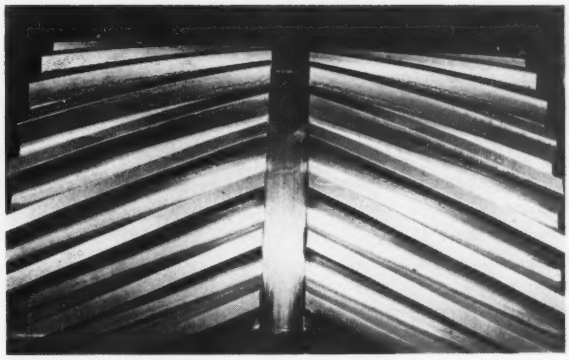


Fig. 12. 30" Mill No. 4 Pinion—1956.

MODIFICATION	DYNAMIC LOAD	WEAR LOAD
1- CHANGE HELIX ∠ TO 30°	179,842	166,000
2-CHANGE TO 1¼ D.P.	180,000	147,200
3- INCREASE CENTER DISTANCE	158,215	168,000
4-CHANGE TO 350 BHN	179,842	268,700
5- COMBINE 1 AND 4	179,842	302,700
6 COMBINE 3 AND 4	158,215	306,100

Fig. 13. 30" Mill Modification Study—proposed changes to pinions.

(realizing the space limitations) might be made to improve the situation.

The greatest *single* improvement can be attained by changing the hardness to 350 Brinell. This would certainly point up the need for improved metallurgy. Heat treating and grinding facilities are claimed to be the limiting factors on pinions of this size. It would appear therefore that some attention should be given to improving these facilities, otherwise the condition indicated by these pinions will be with us for a long time.

In this case, the only attempt at correction has been to follow the vendor's subsequent recommendation, that a different and more viscous lubricant be substituted. The photos reveal that pitting has not ceased and ultimate failure by pitting seems a foregone conclusion.

In a duplicate installation, the vendor added 12 inches to the face and immediately corrected the difficulty. The limit load for wear was raised by 14% and so far these pinions are in excellent condition (Fig. 14).

This installation seems to point up the fact that correction of pitting difficulties cannot be effected by use of E—P lubricants. Further, the Buckingham criterion seemed to work as a forecast of the fact that the pinions were inadequately designed. From this point on, in our illustrations, we find the conclusion to be the same — the Buckingham criterion, comparison of the limit load for wear vs. dynamic load, faithfully forecast the condition of the gear teeth regardless of the lubricant used!

COLD STRIP MILL PINIONS

Taking them in chronological order, the 42″ tandem mills were erected in 1936-1937. In 1941 delivery speed was increased from 1200′ per min. to 1800′ per min. All the mill pinions have been in service from the beginning with no E.P. additives ever used. Fig. 15 is typical of all the gears on these stands. The excellent condition of the teeth is apparent. The pinions were case carburized, heat treated and finish ground, and their life seems to be indefinite at this stage, nearly 20 years after installation.

The 56″ Cold Tandem Sheet Mill (our second example) erected in 1947 was originally a 4-stand mill delivering steel at 3000′ per min. Then it was stepped up to nearly 4000′ per min. with the addition of a 5th stand — the fourth stand remaining at 3000′ per min.

Fig. 16 illustrates the general condition throughout. Even here the teeth look good although only a straight mineral oil has been used.

The third study involves a 66″ Cold Sheet Mill where trouble developed despite the excellent experience in the two previous mills. Here, despite lapping in place, initial wear soon occurred in the form of metal displacement and some incipient pitting. Immediately, tricresyl phosphate was added and the scoring diminished, but the pitting continued. Nevertheless, there was some later evidence of work hardening. Figure 17 was taken very shortly after installation. Figure 18 shows the same pinions today. Note the pitting; but these pinions did eventually work-harden, so apparently there is no cause for alarm.

A tabulation of the data, Fig. 19, in all three mills denotes that the 505 Brinell teeth and the 319 Brinell teeth in the 42″ and 56″ Mills, respectively, should be satisfactory whereas the 240 Brinell teeth in the 66″ Mill would be somewhat questionable as the margin of difference between the wear limit load for the dynamic load was the smallest of the group.

With this evidence, we must conclude that the Buckingham criterion certainly forecast the early trend correctly. Providing the limit load for wear is greater of the two, the larger the margin between the wear and the dynamic loads, the better the performance to be expected. Where work hardening can be expected, this margin will increase and provide greater capacity for longer life.

HOT STRIP MILL

The next illustrations are those of hot strip mill pinions, which have also been lubricated with straight mineral oils. The first, Fig. 20, illustrates a failure due to lack of oil after 15 years' service. Observe that the unaffected surfaces of the teeth are in excellent condition after 15 years' service.

Fig. 21, in turn, shows a similar pinion from a later installation (9 years' service) also lubricated with a straight mineral oil. Both of these examples show clearly the excellent tooth condition and are both examples of finishing stand pinions.

Fig. 22, shows a 68″ — No. 4 roughing stand pinion with 9 years' service indicating some wear on the addenda.

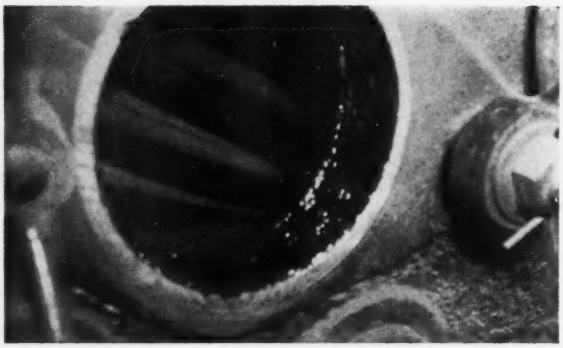


Fig. 14. 30" Mill Longer Face Pinions.

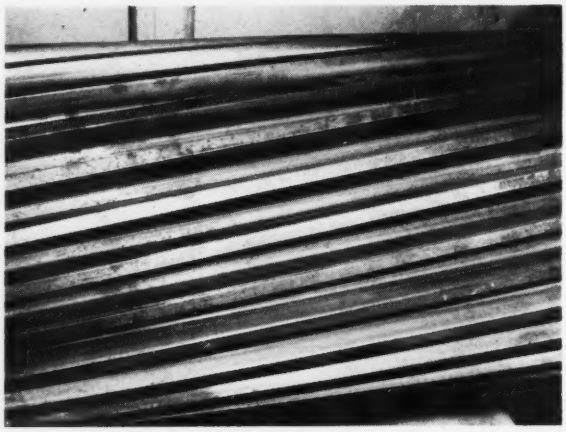


Fig. 15. 42" Cold Strip Mill Pinions.

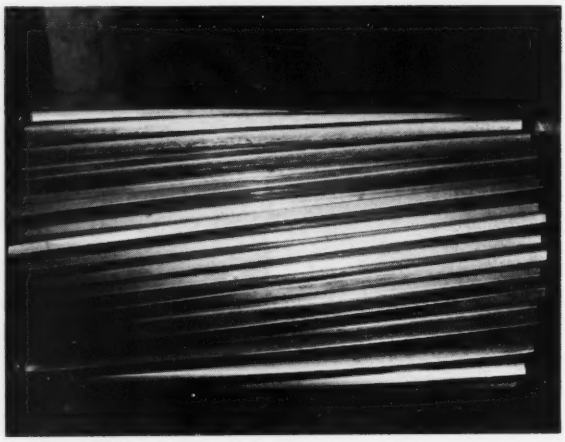


Fig. 16. 56" Cold Strip Mill Pinions.

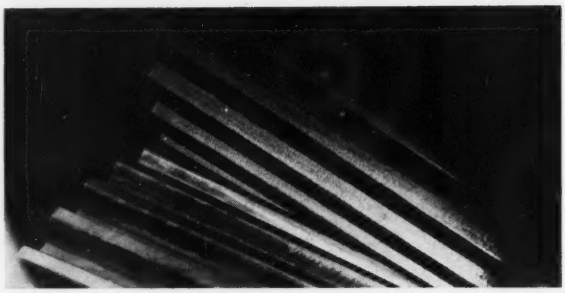


Fig. 17. 66" Cold Strip Mill Pinions (No. 4 bottom).

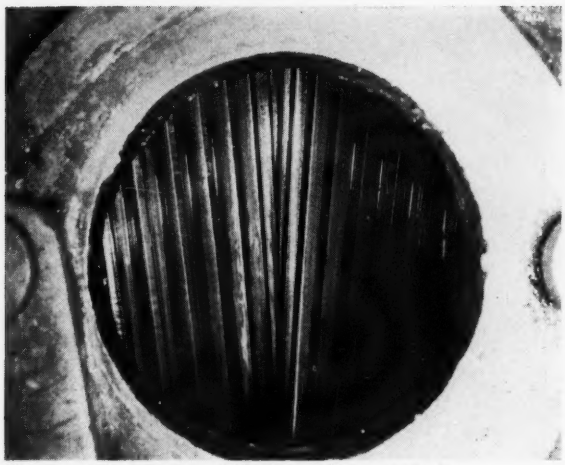


Fig. 18. 66" Cold Strip Mill Pinions (No. 4 today).

MILL	STAND	HARDNESS BHN	FACE IN.	VEL. FPM	H.P. TRANS.	DYNAMIC LOAD #	WEAR CAPACITY #
42"	2	460	32	520	750	184,500	274,000
	5	460	32	1780	750	53,500	274,000
56"	2	311	28	1370	1250	61,600	115,000
	4	311	28	3300	1750	70,500	139,000
66	3 Top	262/277	32	2980	2500	82,600	137,000
	3 Bottom	223/262	32	2980	2500		101,000
	4 Top	255/235	32	3142	2500	83,250	101,800
	4 Bottom	255/235	32	3142	2500		97,500

Fig. 19. Cold Strip Mill Pinion Study.

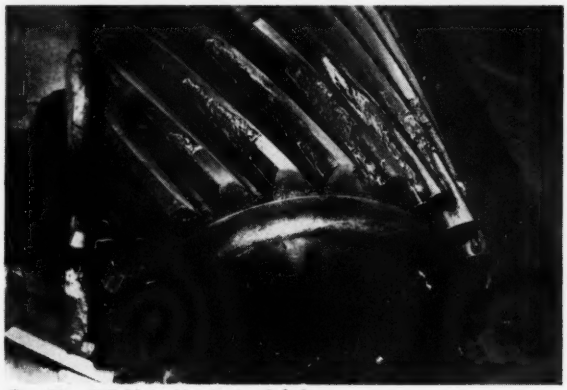


Fig. 20. 56" Hot—No. 5 stand failure.

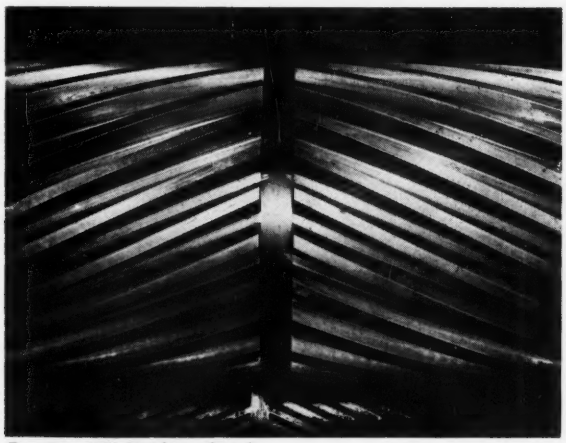


Fig. 21. 68" Finishing Stand.

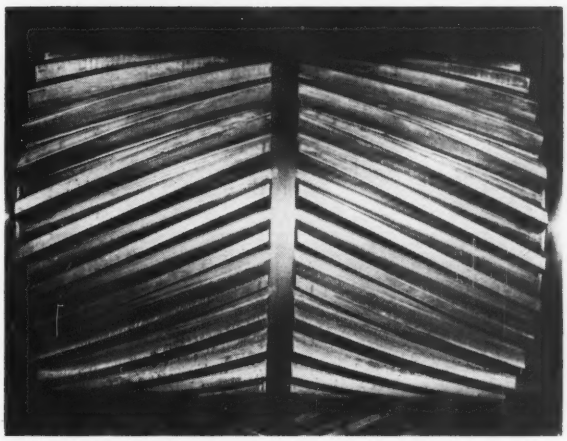


Fig. 22. 68" No. 4 Stand.

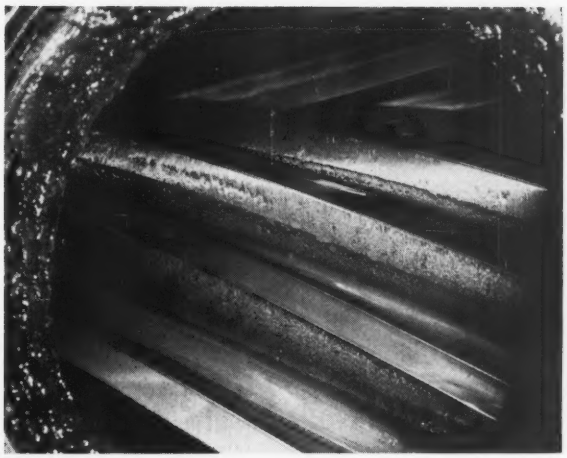


Fig. 23. 68" No. 2 Roughing Stand.

The worst conditions (See Fig. 23) exist on No. 1 and No. 2 roughing stands where shock and impact loads are extremely high. Pitting is a serious factor on these stands and we believe only a tougher, harder gear will withstand the conditions. A table denoting typical dynamic wear loads on these stands is given (Fig. 24). Note that where a considerable safety margin has been given these pinions — their performance has been good, otherwise bad.

Data on Fig. 25, in turn, illustrate a typical rolling schedule per stand on hot strip mills and are indicative of how loads are distributed among the various stands.

MISCELLANEOUS EXAMPLES

By just one of those unfortunate circumstances, the manufacturer of a set of plate mill pinions lapped them in his shop on the unloaded side of the teeth. Consequently, the loaded face had tool mark imperfections from the beginning. Fig. 26 shows considerable pitting that appears to be progressive, undoubtedly continuing until the gears are reversed. These pinions were lubricated from a central oiling system with a lead naphthenate type oil. Regardless of the oil, or even in this case of the wear capacity of the pinions, poor surfaces may be responsible for early failure.

HOT STRIP MILL PINION STUDY

MILL	STAND	HARDNESS BHN	FACE IN.	VEL. F.P.M.	H.P. TRANS.	DYNAMIC LOAD #	WEAR CAPACITY #
56"	#1	276	48	190	2550	519,000	324,000
	#5	322	48	460	2650	208,000	283,000
68"	#2	285	48	200	3285	616,000	333,000
	#4	285	48	475	4560	332,000	288,000
	#10	285	48	1950	3150	106,000	220,000

Fig. 24. Hot Strip Mill Pinion Study.

A blooming mill set of pinions of 3400 lb. per inch of face with eight years of service and transmitted dynamic load of 213,000 lb. is shown in Fig. 27. The amazing fact is that these pinions were lubricated with a 300 SSU straight mineral oil for all that time.

A final example is a rod mill in which there are numerous stands in tandem reducing two and three strands simultaneously. Billets starting at 2½" x 2½" are reduced down to small wire. Such a mill has reduction gears and mill pinions as in any conventional mill. In one case such a mill had been in operation for 18 years rolling two strands simultaneously, lubricated by 560 SSU straight mineral oil on the entire drive. Despite misgivings of the equipment builder, the gears and pinions did very well with no gear difficulty during that time.

Then the mill was converted into a 3-strand mill and most of the heavy loading concentrated on the first four roughing stands. Trouble began immediately. The spiral bevel roughing stand drives made of 1040 gear material began to pit and then break out from overload. In an effort to improve the situation, a lead naphthenate additive-type oil was quickly substituted but to no avail. The troubles continued just the same. The only real relief was noted when case hardened pinions were placed in service. After that, excellent performance resulted until in time the shock loading superimposed on what may be called gradual chemical wear removed the case after which deterioration became quite rapid — See Fig. 28.

In this case, the solution was neither change of oil nor in gear material, but a new drive altogether, with larger tooth bearing surfaces and a harder gear material. (Fig. 29). So the problem was solved by a major operation and not by a mere change of oil. The latter could have retarded welding, but could not check the pitting nor counteract the lack of sufficient beam strength.

While this was going on in the drive, the mill pinions were also failing because of the extra load. The first improvement was to go from a cut gear to a case-hardening and grinding, making use of available grinding equipment. For a while this worked out very well and surfaces were bright and polished. As before, the lead naphthenate E.P. oil was used. However, after only about a year, the teeth simply crumbled. The hardened case was gone. Another solution was needed. It would have been wonderful if an oil were available to do the job, but this again was a problem where change of oil was not likely to help.

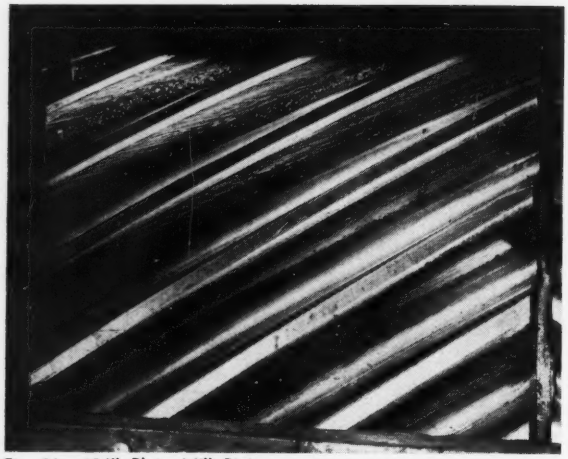


Fig. 26. 134" Plate Mill Pinion.

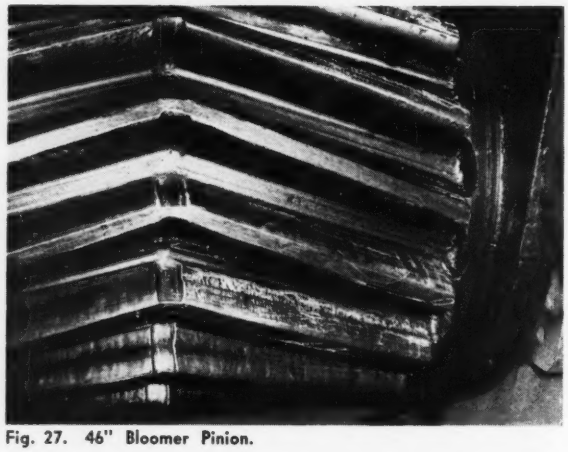


Fig. 27. 46" Bloomer Pinion.

GRINDING PROCEDURE

Just about this time a Swiss method for grinding gear teeth was under study. The practice of carburizing on large gears had been limited by the availability of grinders capable of grinding their teeth accurately and to a very high degree of smoothness.

Heat treatment always causes some distortion. The harder the surface, the more essential it becomes to provide an accurate tooth form, else early pitting and breakage are almost certain. For the reason that grinding facilities have been limited, tooth hardness has had to be sacrificed somewhat. Since the Swiss machine and method appeared to be applicable

		STAND NUMBER										
		1	2	3	4	5	6	7	8	9	10	11
56" MILL	MOTOR RATED H.P.	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	—
	NORMAL PEAK H.P.	5100	6230	5300	6710	5260	4460	4460	4700	4460	2000	—
	DYN. LOAD/PINION 1000 #	519	281	209	262	208	116	95	84	85	64	—
	#/IN FACE/PINION	10,800	5,850	4,350	5,450	4,330	2,420	1,980	1,760	1,780	1,340	—
68" MILL	MOTOR RATED H.P.	2000	3500	4500	4500	4500	4000	4000	4000	4000	4000	3500
	NORMAL PEAK H.P.	3760	6570	9400	9130	8330	4190	3590	3230	4030	6360	3220
	DYN. LOAD/PINION 1000 #	360	616	468	332	308	212	123	84	85	106	75
	#/IN FACE/PINION	7,600	12,800	9,750	6,930	6,400	4,400	2,560	1,750	1,770	2,200	1,560

Fig. 25. Hot Strip Mill Rolling Schedule.

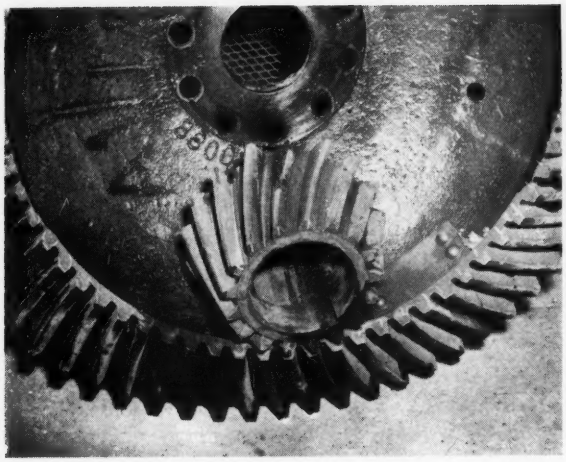


Fig. 28. Rod Mill—Spiral Bevel Gears.

to large steel mill gears, one of the equipment builders cooperated and provided a trial set of pinions case hardened to 426 Brinell.

Ground by this method and without a change in lubrication or loading, these pinions enjoyed an increased life of 300% — see Fig. 29 before service, and Fig. 30 after service.

CONCLUSION

All of us recognize a builder's reluctance to attempt to apply small gear design techniques to large steel mill equipment. We can understand that there is no laboratory as effective as the steel mills themselves. However, we have tried to show how at least one aspect of small gear design might actually be useful as a guide, if not an accurate prediction, of permissible loading of steel mill gearing. We believe we have also demonstrated one further point; lubrication of steel mill gears is only one of the factors affecting a steel mill gear performance — in many cases it is minor.

A lubrication engineer does his best with the methods at his disposal. However, it has been demonstrated that even the best lubricants are inadequate when gear metallurgy and geometry are below standard for the job.

Oftentimes the wear equation denotes that a specific material should be used, but unfortunately one which cannot be handled because of size limitations in our heat

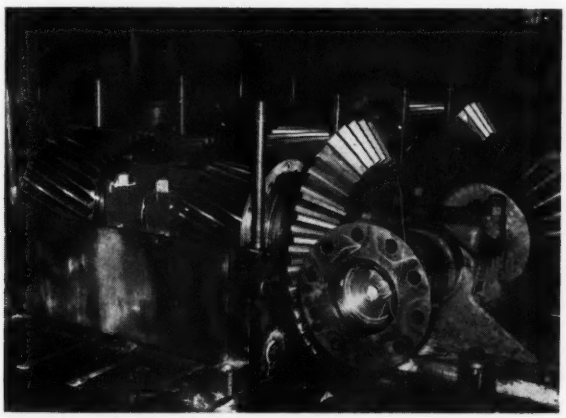


Fig. 29. Rod Mill Straight Bevel Gears.

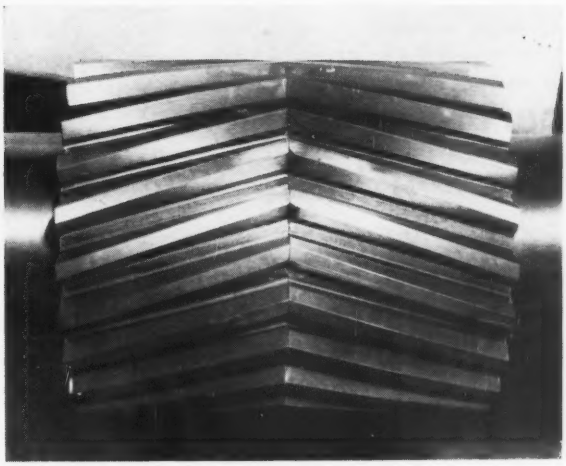


Fig. 30. Rod Mill Special Ground Pinion (before).

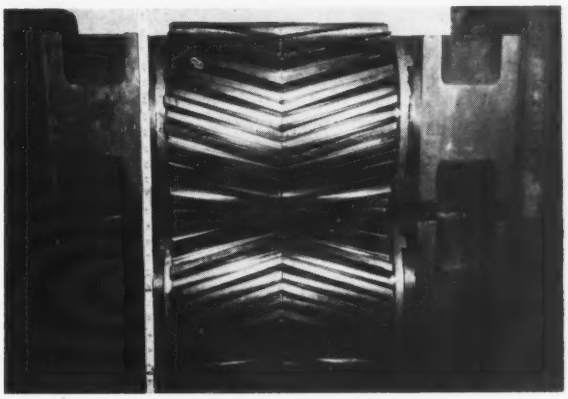


Fig. 31. Rod Mill Special Ground Pinion (after three years).

treating and grinding facilities. This problem should be given special consideration by equipment builders.

We know of no lubricant that can substitute for toughness and hardness when these two factors are demanded. Ample anti-wear capacity is the best guarantee against early failure. Perhaps in steel mill gearing Buckingham's wear load limit should be equal to 1.5 times the anticipated dynamic load. Where we have had such margins, our gears have lasted longer with minimum wear even though they were lubricated with straight mineral oils.

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Service Experience With a New Multipurpose Industrial Grease

S. R. Calish, Jr., California Research Corp., Richmond, Calif.

The discovery of a new synthetic gelling agent has led to the development of a multipurpose industrial grease having widespread application. The novel thickener has made it possible to realize the advantages of a multipurpose lubricant without undue compromise of the important lubrication properties obtained with specialized greases. Because the new grease is compatible with all known grease types, no special precautions are required to introduce it into an existing lubrication system. The paper outlines the necessary performance characteristics for greases in many major industries and emphasizes the limiting environmental conditions for each. Specific examples of product application in unusual or severe service are cited.

The recent history of grease research and development is replete with announcements of new, multipurpose greases. Each truly new grease, involving a novel thickener-oil combination, was the result of an effort to extend the utility of the lubricant beyond the load, speed, or temperature limitations of existing products. In so doing, greases were developed that suitably lubricated bearings of equipment operating in environments formerly thought to be too severe for grease lubrication.

With each major grease development, the unusual application became more commonplace. Recently, service requirements have more than kept pace with grease progress. Today, factors such as high speed (DN values above 2×10^5), extreme temperatures (below —65°F and above 400°F), and radiation resistance are being superimposed upon the normal environmental hazards and militate against the chances of formulating a truly all purpose grease. While it is true that these excessively severe services are unusual today, and often do not involve the volume of lubricant which makes extensive research and development desirable, the specialized greases of today become the basis for the multipurpose greases of tomorrow.

Greases have always been multipurpose lubricants. Ever since animal fats were first applied to the wheels of carts, greases have not been confined to single applications. One of the earliest greases, using a lime-tallow thickener, is still a widely used lubricant. By many standards it is a multipurpose grease.

What distinguishes modern multipurpose greases from their early counterparts? For one thing, they are useful over wider ranges of temperature, load, and speed. More factors influencing their acceptance have been considered during their development. Such things as pumpability, compatibility, and toxicity are usually evaluated in addition to the normal performance criteria. As a result, some multipurpose greases are available which necessitate little or no compromise when applied to equipment normally using specialized products.

The multipurpose character of today's greases is a planned feature, not just the result of extension of field use. These lubricants must compete directly with specialized products and often must provide service superior to that of conventional greases to compensate for their sometimes higher cost.

The advantages of an outstanding multipurpose industrial grease accrue to both supplier and consumer. Considerable simplification in lubricant storage and application results. Fewer lubricants are needed; therefore, fewer need be manufactured. Misapplication of grease is avoided. If one grease can perform the tasks of many, it insures that the proper lubricant is used in most cases. Automatic dispensing equipment is more likely to be employed when large volumes of grease are handled. This eliminates contamination resulting from hand filling of small grease guns or hand packing bearings from small containers. Less storage space, less dispensing equipment, more foolproof application, simplified training of lubrication personnel, and lower maintenance costs arising from contaminated lubricants are a few of the economies realized. The benefits are achieved only if the multipurpose grease can be substituted for the bulk of greases used. They are maximized if it can serve alone.

The laboratory phases of the development of a new multipurpose industrial grease have already been reported[1, 2]. Preliminary evaluation of the new product was so encouraging that an extensive service test program was initiated. After more than a year of extensive tests, the product was commercialized. Several tests in electric motors are still in progress after almost three years of operation. In this paper, service experience with the new grease, both before and after becoming a branded product, is summarized. Special attention will be given to performance in critical applications.

GENERAL PERFORMANCE REQUIREMENTS

Early in the development stages of this new multipurpose industrial grease, our conception of the performance requirements for the major industries of the West Coast was summarized. Later, prior to selecting service test locations, these requirements were analyzed to decide which industries offered the most severe test of product quality.

● IMPORTANT ◐ DESIRABLE ○ NOT REQUIRED

INDUSTRY	REQUIREMENT									
	WORK STABILITY		HEAT RESISTANCE		MOISTURE RESISTANCE		PUMPABILITY	WEAR	LOW TEMPERATURE START	COMPATIBILITY
	GENERAL	OVER-LUBED BEARINGS	GENERAL	OXIDATION	WATER	RUST				
ELECTRIC MOTORS	◐	○	●	●	○	◐	○	●	◐	●
METALWORKING	●	●	◐	○	●	◐	●	●	○	●
LUMBERING	◐	◐	●	○	●	●	●	◐	●	◐
FOOD PROCESSING	◐	●	◐	◐	●	●	●	●	◐	●
GENERAL MFG	●	●	◐	◐	◐	◐	●	◐	◐	●
CONSTRUCTION	◐	●	◐	○	●	●	●	◐	●	◐
TRANSPORTATION	◐	○	○	○	◐	◐	●	●	◐	●
AGRICULTURE	◐	◐	○	○	●	●	●	◐	●	◐
MINING	◐	◐	●	◐	●	●	●	●	◐	◐

Figure 1. Performance requirements for greases in industry.

● OUTSTANDING ◐ SATISFACTORY ○ POOR

TYPE OF GREASE	REQUIREMENT								
	WORK STABILITY		HEAT RESISTANCE	MOISTURE RESISTANCE		PUMPABILITY	WEAR	LOW TEMPERATURE START	COMPATIBILITY
	GENERAL	OVER-LUBED BEARINGS		WATER	RUST				
SODIUM OCTADECYL-TEREPHTHALAMATE	●	●	●	◐	●	●	◐	●	●
SODIUM STEARATE	○	○	◐	○	○	○	◐	○	○
SODIUM TALLOWATE	○	○	◐	○	◐	○	◐	○	○
CALCIUM TALLOWATE	◐	◐	○	●	○	●	◐	◐	◐
LITHIUM STEARATE	○	○	◐	●	◐	◐	◐	●	◐
LITHIUM HYDROXYSTEARATE	●	◐	◐	●	◐	●	◐	◐	◐
INORGANIC	●	●	●	●	○	●	○	◐	○

Figure 2. Performance of Terepthalamate and conventional greases.

Figure 1 shows our estimate of the performance requirements for greases in industry and gives the approximate relative importance of these properties in each field.

Many conclusions may be drawn from this illustration, but of principal interest is the fact that each grease property is critical in some industry. This means that a true multipurpose lubricant must provide performance equal or superior to that of specialized greases in all cases, with essentially no compromise. This was the goal of the research effort, and the service experience described in this paper verifies our preliminary evaluation.

Progress in the design of automatic lubrication equipment plus the increasing complexity of the lubrication function have combined to introduce automatic grease dispensing devices into almost every industry. The importance of the pumpability or dispensability of a multipurpose grease is highlighted by this property, being so designated on the chart more times than any other. Considerable effort has been spent in studying the flow properties of greases, and this work has enabled us to select the proper grease consistencies to provide adequate pumpability under most ambient temperature conditions.

The chart indicates that the next most important feature of a multipurpose grease is compatibility[3]. When a new grease is introduced into a lubrication system for the first time, it mixes with the product normally used unless the system is thoroughly cleaned of residual grease. If mixing occurs, it is essential in most industries that no adverse effect upon grease performance be encountered.

Corrosion prevention has occupied an important segment of the industrial research field. U. S. industry loses millions of dollars annually to the effects of rust and corrosion. It is a decided service advantage to be able to offer a grease which not only prevents rust while equipment is in operation but can be used as a preservative for idle machinery and bearings. Also, in process industries, water is constantly washing away grease and promoting corrosion. Based on the frequency of solid dots on the chart, these features, which we call moisture resistance, rate third in importance for a multipurpose grease.

THE TEREPHTHALAMATE MULTIPURPOSE INDUSTRIAL GREASE

The development of the novel thickener (sodium octadecyl terephthalamate), when coupled with a quality base oil and additives, made possible service tests in applications formerly calling for highly specialized greases. This service evaluation was not undertaken before laboratory performance had been completely determined. Table I summarizes the properties of the new grease as determined by laboratory test. A complete discussion of this testing is given in the Dreher, Hotten, and Carter paper[2] cited previously.

Using the same criteria as given in Figure 1, the performance of the terephthalamate grease is compared with other conventional products in Figure 2. Some of those materials listed would be considered specialized products, while others represent current multipurpose greases. In our evaluation, the terephthalamate grease more nearly represents the performance level required of a multipurpose industrial grease. It is outstanding in eight of the ten categories and poor in none.

The service experience described in this paper was obtained during one year of controlled testing in various industrial plants and over two years' experience since commercialization. In the field test stage, 27 different indus-

TABLE I PROPERTIES OF SODIUM OCTADECYL TEREPHTHALAMATE GREASE

Mineral Oil Viscosity	
ssu at 100°F	600
ssu at 210°F	66
Viscosity Index	85
ASTM Dropping Point, °F	580
ASTM Penetration	
Unworked	220
Worked	250
Work Stability	
ASTM Pen. After 100,000 Strokes	310
Roll Test—ASTM Worked Penetration After	
4 hours	282
64 hours	309
1000 hours	315
Bearing Life — Federal Test Method Standard No. 791, Method 331.1	
Hours at 300°F, 10,000 rpm	1250
ASTM Oxidation	
Pressure Drop at 100 hours, psi	6
Pressure Drop at 500 hours, psi	10
Water Resistance	
Decomposition in Boiling Water, 1 hour	None
MIL-L-3545 Water Resistance	2% Loss
MIL-G-10924, Amend. 3 Water Stability	Pass
Rust Protection	
MIL-G-3278A	Pass
Apparent Viscosity	
Poises at 32°F, 200 sec^{-1}	390
Falex Wear, 500 Pounds, 30 Min	
Steel on Steel	Lower than average
Almen Wear, 8 Pounds, 5 Min	
Bronze on Steel	Lower than average

Figure 3. Primary fan bearings—cement kiln.

trial concerns participated. Over 30,000 pounds of grease were used in these tests. Some 21 different, conventional greases were normally employed in the applications selected. After one year's marketing of the new product, sales personnel were asked to cite unusual uses of the grease. From these "case histories", examples of limiting environmental conditions were chosen to illustrate severe service requirements faced by a multipurpose grease.

LIMITING ENVIRONMENTAL CONDITIONS IN INDUSTRY

Unusual operating conditions may be encountered in any industry. The manner in which a grease is applied, the location of equipment, and the nature of the product may all influence the severity of lubrication. In some cases, high temperatures are the limiting factor; in others, extremely wet conditions prevail. Contamination is a hazard frequently encountered. In many instances, two or more of these adverse factors combine to place a heavy operating burden upon the lubricant.

Two other adverse operating conditions are less often recognized. Overlubrication of antifriction bearings places a premium on the work stability of lubricating greases. Secondly, as discussed earlier, new greases must be compatible with existing products. Not a single case of incompatibility occurred in field service in which the new grease was mixed with 21 other types of conventional greases. All the usual commercial soap bases were included in the 21 greases.

High Temperatures

Heat limits grease performance in more cases than any other single factor. Heat resistance is a necessary quality for any multipurpose product. To be truly heat resistant, a grease must not soften excessively nor melt at the operating temperature. It must also be able to function normally over long periods of time at elevated temperatures. To do these things, a grease must have a high melting point and resist oxidation.

High temperature applications of terephthalamate greases have been numerous. These involve temperatures of 400°F and over with frequent relubrication and in sealed antifriction bearings at somewhat lower temperatures. Electric motors in hot locations, dry kiln fan jackshaft bearings, hot oil pumps, drying oven fans, ore slingers, and draft fans are just a few examples of grease-lubricated equipment where heat resistance is important.

One of the first high temperature applications experienced was in the primary fan bearings of cement kilns, shown in Figure 3. Heat from the burner end of the kiln is radiated to this area and superimposed upon bearing-generated heat. Originally, temperatures were in the order of 250°F. Application of terephthalamate grease dropped temperature to about 175°F. This work-stable grease fed gradually to the bearing and eliminated that portion of heat caused by excessive circulation of grease.

The hot oil pump of asphalt hot-mix plants feeds asphalt at 400°F and above into the blending section of the plant. After a few minutes operation, the entire pump is at this temperature. Only greases which are not fluid at the operating temperature will lubricate these pumps. The sodium octadecyl terephthalamate thickener is one of the few materials that will withstand this temperature. The pump is shown in Figure 4.

In one of the service tests which could be readily analyzed statistically, the terephthalamate grease was used to pack the bearings of fans used to circulate a reducing atmosphere in annealing ovens in a large West Coast steel mill. Failures had been numerous in this equipment, principally due to overlubrication. More than 200 fans are used in the annealing bay of this mill. Bearing temperatures average 240°F. Twenty-four 7½ hp, 3450 rpm fan motors were lubricated with this grease, while ten were packed with the product for reference purposes.

At the start of this test, it was recommended that bearings be packed with grease and that lubrication fittings be removed. In the first three months' operation, six motors lubricated with the regular soda base ball bearing grease failed. The terephthalamate grease, however, has provided excellent lubrication for over 2½ years without relubrication and has been adopted throughout the plant by the electrical department.

Heat Plus Moisture

It is not unusual to find the combined effects of heat and moisture working together to diminish the effectiveness of lubricating grease. Even at temperatures above the boiling point of water, steam may be used to control humidity or in processing materials.

A new and very severe application for grease in the lubrication of aseptic canning machines. Superheated steam is used to sterilize cans and evacuate containers, all in one operation. Temperatures up to 500°F are encountered and moisture is always present in cooler locations. A photograph of this equipment is shown in Figure 5, which indicates the variety and complexity of the lubrication job. Conventional greases merely become liquid and run out of the lubricant passages. Terephthalamate grease permits satisfactory operation of this machine.

To control the rate at which water is removed from lumber in a dry kiln, steam is introduced into the hot air stream. Heat plus moisture is encountered in the center fan bearings of such installations. These are large, high speed, rolling contact bearings

Figure 4. Hot oil pump bearings — asphalt plant.

lubricated through fittings located outside the fan duct. A typical installation is shown in Figure 6.

Again, in the lumber industry, high speed bearings in the band saw head rig sometimes operate at temperatures above the boiling point of water. The lower bearing, Figure 7, is continuously subjected to the washing action of water used to cool the saw blade. Many sawmill applications are similar, differing only in the degree of hazard to effective lubrication. The new grease actually proprovided improved performance in this equipment.

An unusual application in which high temperatures and moisture combine is in ball bearing, swivel steam joints, such as are found in the chemical, petroleum, and paper industries. The steam heated dryer rolls of a paper machine are shown in Figure 8. In this case, 150 pound, 350°F steam passes through the joint. The lubricant permits movement of the joint and acts as a seal. The new, multipurpose industrial grease is the only product which remains in the joints, with the exception of costly synthetic greases.

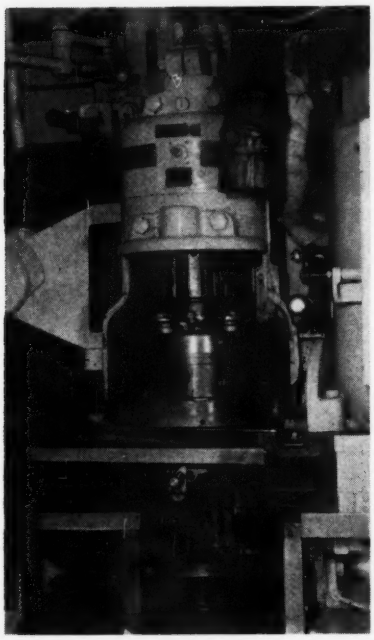

Figure 5. Aseptic canning machine.

Water Contamination

Lubricating greases may encounter water in almost any industrial application. Direct entry of water into bearings occurs when seals are inadequate or in poor condition and when grease does not adhere to the journal to form a sealing collar. In many cases, equipment design accentuates this problem, especially in the food processing, metal working, and forest products industries. It is customary in canneries, breweries, bakeries, and dairies to wash down all equipment with a high pressure, hot water hose. This is done to maintain cleanliness, but its effect on lubrication can be disastrous. An example of a modern, high-speed beer can closing machine which is subjected to this treatment is shown in Figure 9. Water washing, coupled with high rotating speeds, contamination with beer, limited lubricant reservoir, and close tol-

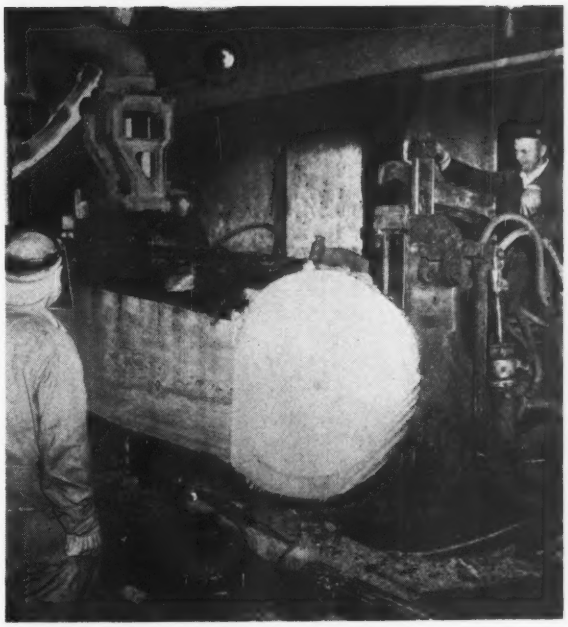

Figure 7. Band saw head rig and carriage.

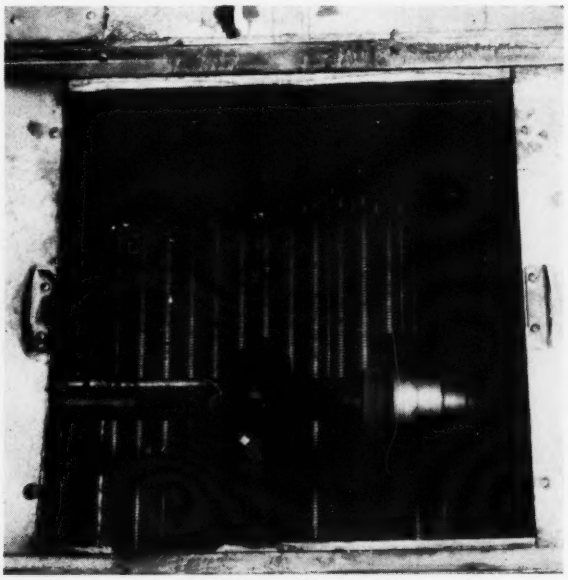

Figure 6. Center bearing — lumber dry kiln fan.

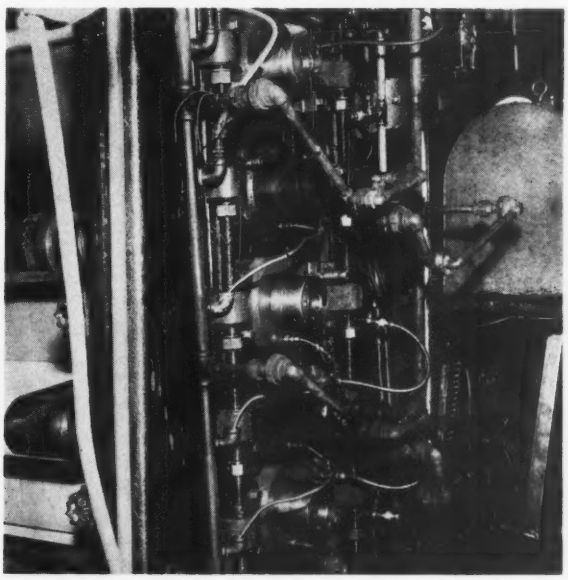

Figure 8. Ball bearing swivel steam joints on paper machine.

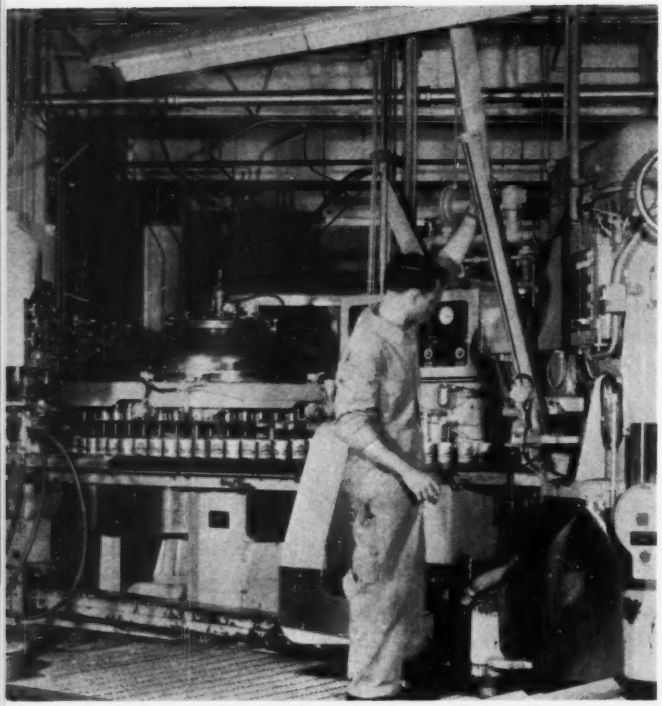

Figure 9. Beer can closing machine.

erances, provide a severe test of a lubricant. Terephthalamate greases successfully meet the requirements of this service.

In some industries, bearings are called upon to operate submerged in water. While the bearing housings are considered to be totally enclosed, such is rarely the case. The lower bearing of the green chain of a modern sawmill is under the surface of the water of the log pond. It is usually a babbitted journal bearing, and the grease must provide the seal. Greases must withstand the washing action of water and at the same time tolerate a certain amount of admixture with it. The new grease provided satisfactory lubrication despite submergence in water. Figure 10 shows typical log pond and green chain.

During the early service test work with terephthalamate greases, an opportunity was offered to lubricate mine car wheels operating submerged in mine water. This situation prevailed in the construction of a seven mile long, twenty-five foot bore tunnel for one of the large hydroelectric plants in California. Contamination and corrosion of mine car wheel bearings were a constant headache, and operation was maintained only by lubrication of the wheel bearings three times a day. Figure 11 gives an indication of the extent of the problem. The new grease not only provided better lubrication in the presence of water, but reduced corrosion of bearings to a tolerable level. Lubrication intervals were gradually extended to weekly periods.

This grease has also found eager acceptance in the marine trade. The advantages of a multipurpose grease are apparent when the limited storage space and frequent change of personnel of a working vessel are considered. In a typical tanker operation, the water resistance and rust protective properties of the product made it possible to replace four other greases. On tankers, much of the topside equipment, of which the forward anchor winch, Figure 12, is an example, is subjected to the washing action of sea water. A grease must have excellent water resistance, adhere to metal surfaces, and provide corrosion protection to lubricate satisfactorily in these locations.

Rust Protection

While rust protection is a phase of over-all water resistance, it is mentioned separately here because of its importance in the seasonally-operated equipment typical of a large segment of West Coast industry, such as logging, farming, and food processing. When equipment is laid up for extended periods, especially if no precautions are taken to preserve it, protection of bearing surfaces is the responsibility of the lubricant. Rust preventive additives can be used in most greases to accomplish this; however, some grease thickeners will not tolerate surface active materials.

Figure 10. Log pond — green chain.

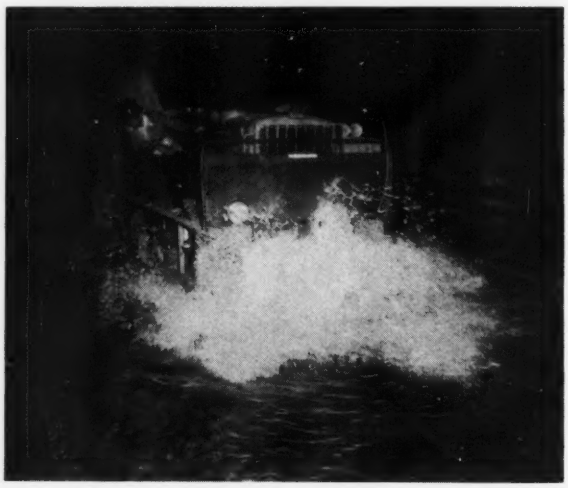

Figure 11. Mine car in typical wet operations.

A good example of the type of corrosion encountered in seamer roll bearings of a can-closing machine is shown on the bearings at the top of Figure 13. The lower bearings were in identical service but were lubricated with the new, rust inhibited, multipurpose industrial grease.

Excessive Working of Grease

In today's modern machinery, excessive working of the grease is frequently a limiting environmental factor. More and more plants are adopting centralized grease dispensing equipment. Whether this is manually or automatically operated, the result may be overlubricated bearings. This is true because the systems mechanically feed metered amounts of grease to each bearing regardless of the changing lubrication requirements of the bearing.

Successful operation of overlubricated antifriction bearings requires highly work-stable greases. When greased by hand gun until all clearances are full of lubricant, high-speed antifriction bearings may shear greases to the point of fluidity before the lubricant can escape from the working area.

Steel rolling mills provide excellent examples of automatic, centralized grease-dispensing systems, feeding as many as 200 bearings per pump. In a mill hot-rolling steel plate and sheet, a grease may be severely worked in bearings subjected to heat and water contamination. Unless an extremely heat- and work-stable multipurpose grease is used, there is a pile of grease under every bearing in the mill due to leakage.

The bearings in modern, high-speed news presses are precision roller bearings which have more than the usual number of rollers per bearing to permit precise index of press roll position and to maintain that adjustment. This bearing design allows little room for grease, and what grease is applied is constantly under shear. As these presses turn out 28,000 copies per hour, the roll speed and shear rate are high. The work stability of the terephthalamate grease permitted satisfactory lubrication of the bearings of the Hoe press, shown in Figure 14, with no lubricant loss due to leakage.

Pumpability

The pumpability of lubricating greases is determined by two factors, feed to the pump suction and flow through long pipelines or hoses. When considering portable, air-operated dispensing equipment, as used in the transportation, contracting, agriculture, and logging industries, the ability of a grease to flow to the pump suction is of major importance. Freedom from pump cavitation is determined by the unworked consistency; and for reasonable ambient temperatures (down to +20°F), greases having a minimum penetration of about 250 at 77°F appear to function satisfactorily.

The use of efficient follower plates in both portable and permanent grease dispensing equipment eliminates the cavitation problem. Most automatic dispensing pumps are fitted with air-pressurized follower plates to feed grease positively to the pump suctions.

The second aspect of pumpability is flow in long lengths of pipe and hose. When the long lines of centralized grease dispensing systems are considered, this becomes the important limiting factor. The apparent viscosity of a grease and its change with rate of shear and temperature are the principal variables affecting pumpability of the lubricant. The viscosity-temperature characteristics of the mineral oil component play a big part in determining this relationship.

If the piping is too long, or if it is not properly protected from very low temperatures, grease pumpability may be less than expected. In one West Coast steel mill, the delivery end of the rolling mill building is not protected from the weather. Temperatures may drop to —10°F in a location where automatic systems are feeding run-out table bearings. Despite these low ambient temperatures, the pumpability of the terephthalamate grease was adequate in the dual line system feeding over 200 bearings through 550 feet of ½-inch pipe. This is a longer run than the maximum recommended by the grease pump manufacturer.

An unusual pumpability difficulty experienced with the multipurpose grease has been in the direction of over-pumpability. Because of the thickener particle size and shape, and the viscosity characteristics of the base oil, this grease is more readily pumped than conventional greases of similar ASTM worked penetrations. For this reason, lubrication personnel using high pressure hand guns have had to be cautioned about overgreasing.

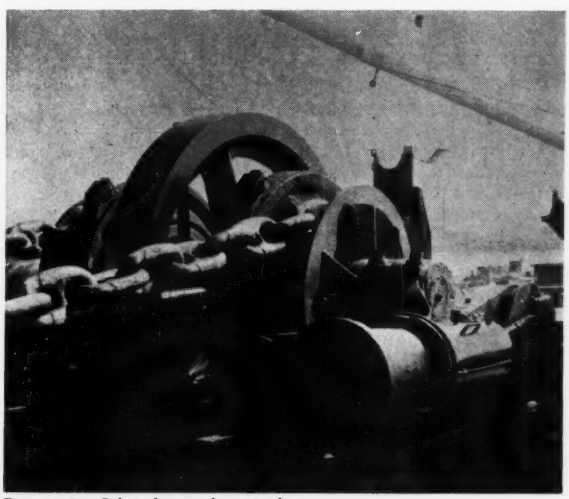

Figure 12. Oil tanker anchor winch.

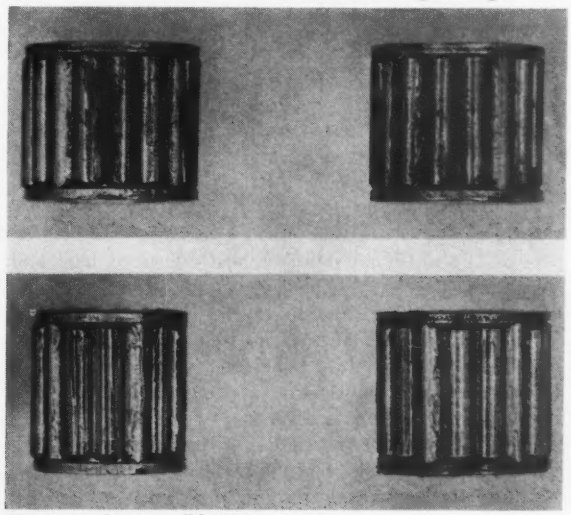

Figure 13. Seamer roll bearings.

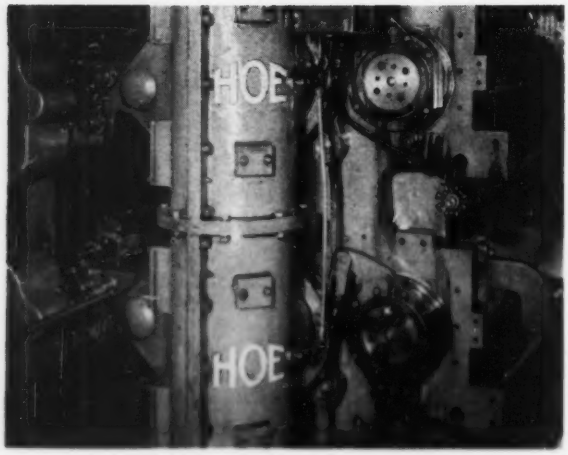

Figure 14. High speed news press.

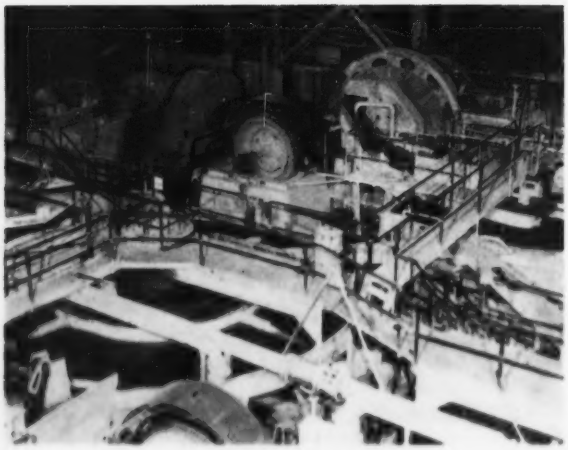

Figure 15. Crusher house — cement plant.

grease. While this discoloration may be objectionable to

A Field Study of Gas Engine Lubricants

C. M. Floyd, Humble Oil & Refining Company, Baytown, Tex.

This paper discusses the results of field tests of several years duration covering the use of gas engine lubricants, of both naphthenic and paraffinic base stocks, in detergent and non-detergent formulations. These tests were made in both [illegible] and four-cycle gas engines. The effects of these

the author's company has been carrying out field test studies on the problem for the past several years. An important aspect of this study has been to evaluate the effect of additives on lubricant performance. It is the purpose

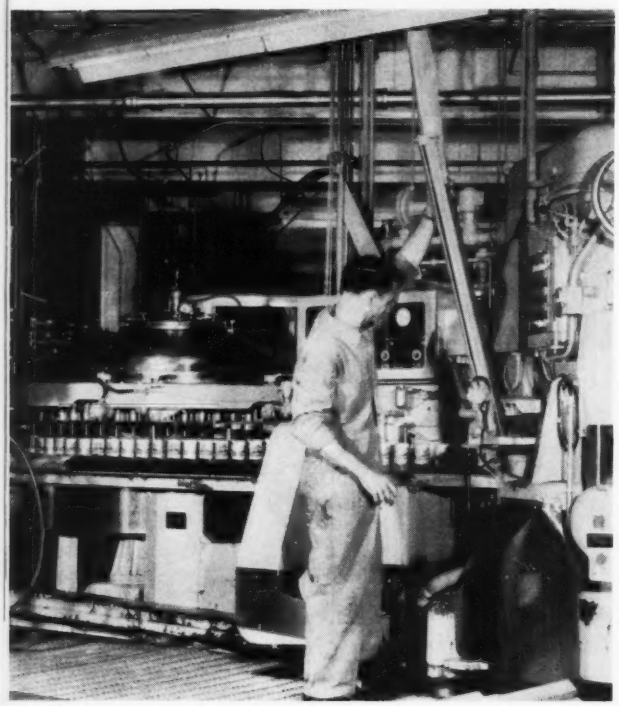

Figure 9. Beer can closing machine.

erances, provide a severe test of a lubricant. Terephthalamate greases successfully meet the requirements of this service.

In some industries, bearings are called upon to operate submerged in water. While the bearing housings are considered to be totally enclosed, such is rarely the case. The lower bearing of the green chain of a modern sawmill is under the surface of the water of the log pond. It is usually a babbitted journal bearing, and the grease must provide the seal. Greases must withstand the washing action of water and at the same time tolerate a certain amount of admixture with it. The new grease provided satisfactory lubrication despite submergence in water. Figure 10 shows typical log pond and green chain.

During the early service test work with terephthalamate greases, an opportunity was offered to lubricate mine car wheels operating submerged in mine water. This situation prevailed in the construction of a seven mile long, twenty-five foot bore tunnel for one of the large hydroelectric plants in California. Contamination and corrosion of mine car wheel bearings were a constant headache, and operation was maintained only by lubrication of the wheel bearings three times a day. Figure 11 gives an indication of the extent of the problem. The new grease not only provided better lubrication in the presence of water, but reduced corrosion of bearings to a tolerable level. Lubrication intervals were gradually extended to weekly periods.

This grease has also found eager acceptance in the marine trade. The advantages of a multipurpose grease are apparent when the limited storage space and frequent change of personnel of a working vessel are considered. In a typical tanker operation, the water resistance and rust protective properties of the product made it possible to replace four other greases. On tankers, much of the topside equipment, of which the forward anchor winch, Figure 12, is an example, is subjected to the washing action of sea water. A grease must have excellent water resistance, adhere to metal surfaces, and provide corrosion protection to lubricate satisfactorily in these locations.

Rust Protection

While rust protection is a phase of over-all water resistance, it is mentioned separately here because of its importance in the seasonally-operated equipment typical of a large segment of West Coast industry, such as logging, farming, and food processing. When equipment is laid up for extended periods, especially if no precautions are taken to preserve it, protection of bearing surfaces is the responsibility of the lubricant. Rust preventive additives can be used in most greases to accomplish this; however, some grease thickeners will not tolerate surface active materials.

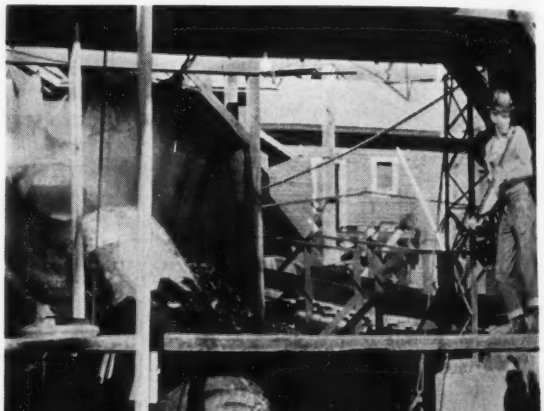

Figure 10. Log pond — green chain.

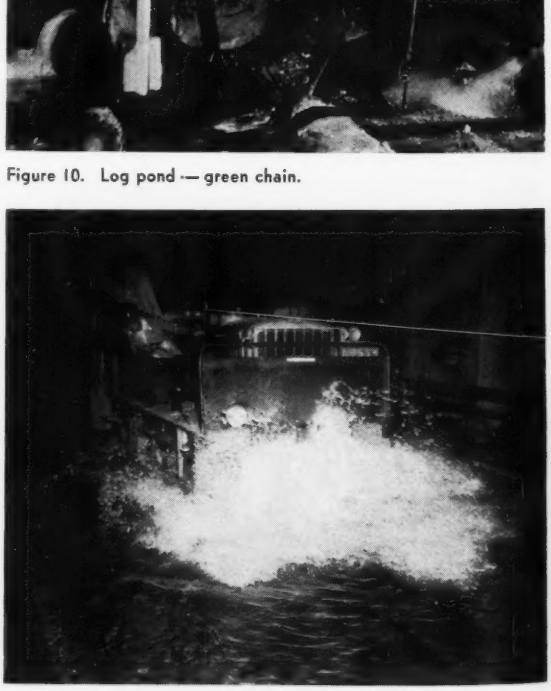

Figure 11. Mine car in typical wet operations.

A good example of the type of corrosion encountered in seamer roll bearings of a can-closing machine is shown on the bearings at the top of Figure 13. The lower bearings were in identical service but were lubricated with the new, rust inhibited, multipurpose industrial grease.

Excessive Working of Grease

In today's modern machinery, excessive working of the grease is frequently a limiting environmental factor. More and more plants are adopting centralized grease dispensing equipment. Whether this is manually or automatically operated, the result may be overlubricated bearings. This is true because the systems mechanically feed metered amounts of grease to each bearing regardless of the changing lubrication requirements of the bearing.

Successful operation of overlubricated antifriction bearings requires highly work-stable greases. When greased by hand gun until all clearances are full of lubricant, high-speed antifriction bearings may shear greases to the point of fluidity before the lubricant can escape from the working area.

Steel rolling mills provide excellent examples of automatic, centralized grease-dispensing systems, feeding as many as 200 bearings per pump. In a mill hot-rolling steel plate and sheet, a grease may be severely worked in bearings subjected to heat and water contamination. Unless an extremely heat- and work-stable multipurpose grease is used, there is a pile of grease under every bearing in the mill due to leakage.

The bearings in modern, high-speed news presses are precision roller bearings which have more than the usual number of rollers per bearing to permit precise index of press roll position and to maintain that adjustment. This bearing design allows little room for grease, and what grease is applied is constantly under shear. As these presses turn out 28,000 copies per hour, the roll speed and shear rate are high. The work stability of the terephthalamate grease permitted satisfactory lubrication of the bearings of the Hoe press, shown in Figure 14, with no lubricant loss due to leakage.

Pumpability

The pumpability of lubricating greases is determined by two factors, feed to the pump suction and flow through long pipelines or hoses. When considering portable, air-operated dispensing equipment, as used in the transportation, contracting, agriculture, and logging industries, the ability of a grease to flow to the pump suction is of major importance. Freedom from pump cavitation is determined by the unworked consistency; and for reasonable ambient temperatures (down to +20°F), greases having a minimum penetration of about 250 at 77°F appear to function satisfactorily.

The use of efficient follower plates in both portable and permanent grease dispensing equipment eliminates the cavitation problem. Most automatic dispensing pumps are fitted with air-pressurized follower plates to feed grease positively to the pump suctions.

The second aspect of pumpability is flow in long lengths of pipe and hose. When the long lines of centralized grease dispensing systems are considered, this becomes the important limiting factor. The apparent viscosity of a grease and its change with rate of shear and temperature are the principal variables affecting pumpability of the lubricant. The viscosity-temperature characteristics of the mineral oil component play a big part in determining this relationship.

If the piping is too long, or if it is not properly protected from very low temperatures, grease pumpability may be less than expected. In one West Coast steel mill, the delivery end of the rolling mill building is not protected from the weather. Temperatures may drop to —10°F in a location where automatic systems are feeding run-out table bearings. Despite these low ambient temperatures, the pumpability of the terephthalamate grease was adequate in the dual line system feeding over 200 bearings through 550 feet of ½-inch pipe. This is a longer run than the maximum recommended by the grease pump manufacturer.

An unusual pumpability difficulty experienced with the multipurpose grease has been in the direction of overpumpability. Because of the thickener particle size and shape, and the viscosity characteristics of the base oil, this grease is more readily pumped than conventional greases of similar ASTM worked penetrations. For this reason, lubrication personnel using high pressure hand guns have had to be cautioned about overgreasing.

Figure 12. Oil tanker anchor winch.

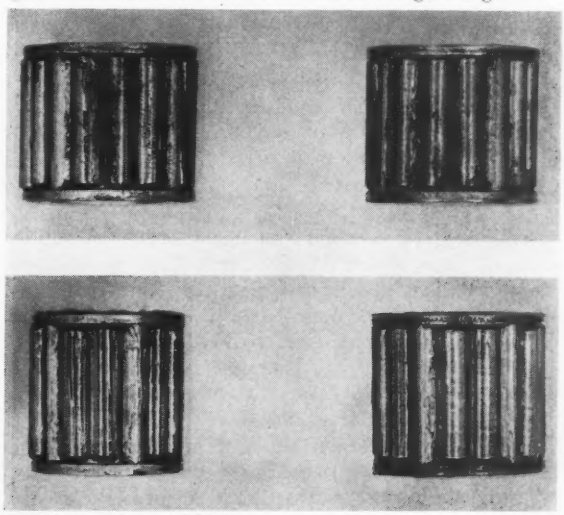

Figure 13. Seamer roll bearings.

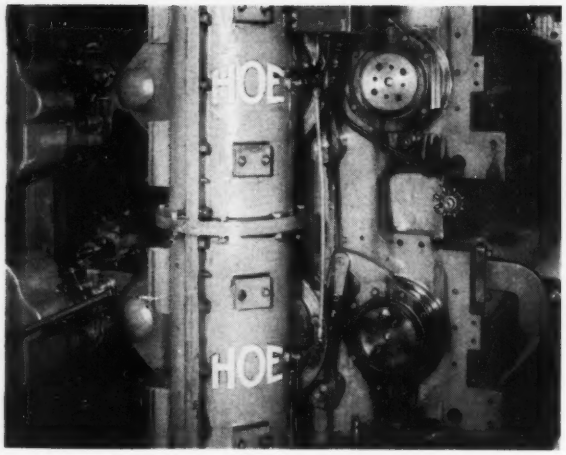

Figure 14. High speed news press.

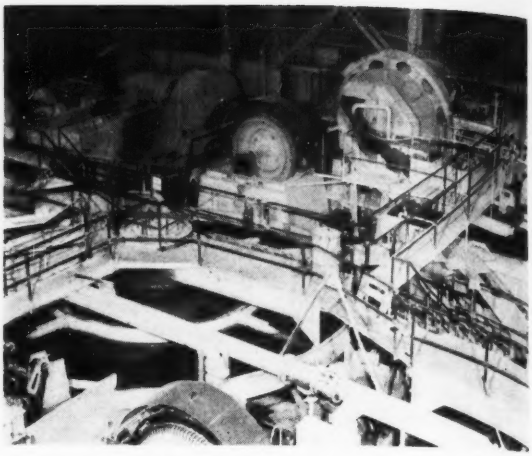

Figure 15. Crusher house — cement plant.

Solid Contaminants

One of the functions of a grease, indeed one of the reasons for using a grease instead of an oil, is to act as a seal to prevent the entry of dust and dirt into bearings. Greases which weakly adhere to metal surfaces, or which flow readily under moderate centrifugal forces, do not form a sealing collar about the clearance between rotating shafts and bearing supports.

Experience with the terephthalamate grease has shown that this product resists throw-off and provides a visible seal about the face of antifriction bearings. In the crusher house of one of the world's largest cement plants, shown in Figure 15, there is ample opportunity for both solid and water contamination to occur. The multipurpose grease demonstrated its ability to seal out contamination in this application.

POSSIBLE IMPROVEMENTS IN THIS MULTIPURPOSE GREASE

Other environmental factors may contribute to limiting the usefulness of a lubricant. Those discussed are the most important and most frequently encountered. This new industrial grease has proved, through satisfactory lubrication in service, that it is the *latest* word in multipurpose lubrication. We do not believe it will be the *last* word.

A softer grade of the new grease than that described in Table I was service tested simultaneously. This softer grease is more readily pumped in the long lines of centralized dispensing systems. It also permits suction filling of hand guns.

A harder version of the terephthalamate grease will be required to withstand the combined effects of heat and vibration found in a few special applications. For instance, the new grease did not lubricate magneto bearings of oil well pumping engines as well as a conventional specialized product. In a hot shaker screen bearing at a phosphate plant, relubrication at frequent intervals was needed to maintain lubrication.

The most effective rust inhibitors used in greases are generally emulsifiable materials. In the presence of moisture, the surface of rust inhibited greases may discolor due to the emulsification of the surface layer of the grease. While this discoloration may be objectionable to the user, it has no functional significance. Non-emulsifiable inhibitors will eliminate this difficulty when effective ones become available.

CONCLUSIONS

Service experience with the terephthalamate grease has proved that it more closely approaches the all-purpose grease than any other commercially available product known to us. Its heat resistance, exemplified by its dropping point in excess of 500°F, has permitted the successful lubrication of machinery that could not otherwise be operated. In the presence of moisture, or heat plus moisture, the grease remains in place and protects the bearing against corrosion. It forms an excellent sealing collar and prevents the entry of harmful contaminants into bearings. The new thickener provides a grease of outstanding work stability, which is so necessary in the lubrication of overpacked antifriction bearings. As described early in the paper, not a single case of incompatibility has been encountered with the new product, although it has displaced nearly every other type of grease now manufactured.

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COMMENTARY

J. A. Bell, Shell Oil Co.

The author presents an excellent review of the functional requirements which the modern multipurpose industrial grease must meet. The laboratory evaluation data illustrate that the terephthalamate grease possesses the desired basic properties. Extensive service experience substantiates that this grease will function in a variety of applications covering a wide range of operating conditions.

(Continued on p. 665)

A Field Study of Gas Engine Lubricants

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This paper discusses the results of field tests of several years duration covering the use of gas engine lubricants, of both naphthenic and paraffinic base stocks, in detergent and non-detergent formulations. These tests were made in both two-cycle and four-cycle gas engines. The effects of these oils on engine wear and engine cleanliness were evaluated. The used oil tests obtained and their significance are discussed also.

The expansion in the utilization of natural gas since the end of World War II has been at an ever increasing rate. One of the prime factors in making this expansion possible has been the development and improvement of the high output, relatively high speed gas engines. These engines have been found to be highly satisfactory for pumping natural gas for repressuring in the production of crude oil and for the recovery of field natural gasoline from the gas produced in the field. They have made possible the development of transcontinental gas pipe lines which have in turn brought gas to areas not previously served by this fuel. They have been used in many installations solely for the production of electric power and in others for processing of chemicals in the expanding petrochemical industries.

With such a wide range of usefulness, problems of lubrication continue to arise as engines are designed and built for new applications. The turbo-charging of engines presents new problems. It has also been found that conventional engines can be turbo-charged by the installation of turbo-charger kits. When the horsepower of the conventional engine is stepped up some 30-50 per cent, new problems of lubrication arise. In line with the development of the gas engine, it has become imperative that studies be made to insure that adequate supplies of high quality lubricants be provided for this growing segment of industry.

Because of the relatively mild conditions generally prevailing in the earlier gas engines, non-additive type oils have gained a wide acceptance in the gas engine field. However, there has been an increasing trend in the industry to use detergent additive type oils in these engines, presumably on the assumption that the improved lubrication and decreased maintenance costs would offset the increased cost of the oils. In view of the very limited data available on the performance of different formulations of lubricants in gas engines of various types, the author's company has been carrying out field test studies on the problem for the past several years. An important aspect of this study has been to evaluate the effect of additives on lubricant performance. It is the purpose of this paper to discuss the results of the field lubricant test program which has involved the field testing of both naphthenic and paraffinic base oils in both two-cycle and four-cycle engines. During this time over one million test hours were logged on these engines. The study is still being pursued intensively.

Presented before the 12th Annual Meeting of The American Society of Lubrication Engineers April 16, 1957, at Detroit, Mich.

PURPOSE AND SCOPE OF PROGRAM

The purpose of the test program was to study under actual field operating conditions the use of oils of widely different compositions in several different types of gas engines. This type of program is essential because there are as yet no really satisfactory screening tests available for accurately predicting in the laboratory what the oil will do in actual field engines.

The scope of this program as discussed here will be concerned with the testing of commercially marketed oils and experimental oils in engines representative of the two-cycle and four-cycle operations.

The oils to be discussed here are of two basic types: that is, (1) 100 plus VI oils from paraffinic crudes and (2) 60 plus VI oils from naphthenic crudes. These oils were tested as uncompounded oils, mildly detergent oils, detergent oils of MIL-L-2104A, Supplement I and Series III levels. The oils tested and the engines used are shown in the table below:

Oil	Composition	Engines	
		2-Cycle	4-Cycle
A	100 + VI Paraffinic Base	X	X
B	60 + VI Naphthenic Base	X	X
C	60 + VI Naphthenic Base (Mildly Detergent)	X	X
D	100 + VI Paraf. Base MIL-L-2104A	—	X
E	60 + VI Naph. Base MIL-L-2104A	X	X
F	100 + VI Paraf. Base Supplement I	—	X
G	60 + VI Naph. Base Series III	X	X

DISCUSSION

Early in the testing work it was concluded that the problems connected with the various types of engines would very markedly influence the types of oils to be tested and the manner in which they were tested. Thus, the two-cycle engines and the four-cycle engines were

considered separately for the purpose of this study. In the two-cycle engine, port plugging and ring sticking are the principal problems. These problems are aggravated by excessive lubrication and appear to be affected by engine and ring design. The crankcase oil requirements are not critical. However, it is customary to use the same oil for both power lubrication and crankcase lubrication.

In the four-cycle engine, which is crankcase lubricated, all of the oil used to lubricate the power pistons in the ring zone comes from the crankcase. Further, it means that many of the products of combustion and partial combustion find their way into the crankcase. Some of the oil that has been in the ring zone where it is exposed to heat, oxygen, and partially burned gases eventually finds its way back into the crankcase. Because of these factors lubrication of four-cycle engines involves two problems. The first of these is adequate lubrication and cooling of the engine. This includes keeping ring zone deposits to a minimum. The second problem is one of preparing oils of sufficient stability that they can resist oxidation, carry particles of soot, carbon, etc., to the filters, and keep the rings and crankcases clean.

At the beginning, it may be well to state one general conclusion that may be drawn from the field test to date. Where engines are kept clean through the use of good oil, and good maintenance, wear is not a problem. Thus with proper oil and the proper maintenance schedule wear rates are low. However, engine cleanliness, as it concerns port plugging, ring sticking, retarded heat transfer, etc., is a problem; and where these factors are allowed to get out of hand, wear then becomes a problem. It is the purpose of this paper to discuss the role of the lubricant in preserving engine cleanliness so that gas engines may be run for years without costly overhauls.

Two-Cycle Engines

The use of intermediate VI naphthenic base oils have long been considered good for the two-cycle engine because of the relatively soft carbon deposits laid down by these oils when compared to the somewhat harder type carbon laid down by the high VI paraffinic type oils. This difference in the properties of the two types of oils does make a difference in the general cleanliness of the two-cycle engine as shown below.

Oil	Two-Cycle Engines Demerit Rating: O = Clean, 10 = Max. Deposit	
	Ring Zone	Overall Piston
A (Paraf. Base)	4.6	3.6
B (Napht. Base)	3.0	2.2

A series of tests was run in the two-cycle engines on a mildly detergent 60 VI naphthenic base Oil C. The oil with the detergent additive performed better in the two-cycle engines than did the straight mineral Oil B. These data are illustrated below:

Oil	Two-Cycle Engines Demerit Rating: O = Clean 10 = Max. Deposit	
	Ring Zone	Overall Piston
B (Napht. Base)	3.0	2.2
C (Napht. Base Mildly Det.)	2.5	1.7

The deposits formed in the engines by Oil C were very soft and crumbled easily. The piston skirts were considerably cleaner and the general appearances of the engines were better than for Oil B. Port plugging was slightly less.

In view of the better performance of the mildly detergent naphthenic base oil over that for the straight mineral oil in the two-cycle engine, it would be expected that a fully detergent oil of MIL-L-2104A level would show further improvement. Such proved to be the case as illustrated in the table below:

Oil	Two-Cycle Engines Demerit Rating: O = Clean 10 = Max. Deposit	
	Ring Zone	Overall Piston
C (Napht. Base Mildly Det.)	2.5	1.7
E (Napht. Base MIL-L-2104A)	2.2	1.4

These improvements of Oil E over Oil C, while small, are real and represent less varnish and less ring sticking than Oil C. Port plugging was reduced over Oil C as was piston skirt varnish.

Many factors enter into the formation of these deposits. It has been shown that high oil rates to the power cylinders adversely affect the deposits. Excessive oil going to the scavenging air pumps increases deposits especially on piston crowns and in the ports. Proper attention given to oil feed rates will be amply repaid by smaller deposits. One of the minor problems with detergent oils is the incompatibility of some additives with the sight feed lubricator fluids. This problem can be remedied easily by the use of the vacuum feeder type lubricator or by the substitution of mechanical bobbers for the sight feed fluid in the ordinary sight feed lubricator.

In summary, it may be said that with identical operating conditions naphthenic oils are superior to paraffinic oils in the two-cycle engine and that detergent naphthenic oils are superior to straight naphthenic oils. It is believed that where conditions are severe, the detergent oils will show to greater advantage than where conditions are mild. Some work is being done on oils of Series III level (Oil G) in severe service. The data, while incomplete, are promising. In this particular service, prior to the use of Series III oils, it has been customary to bring the engines down every eight months. Inspections always showed several rings stuck and some scoring of liners and rings. Recent inspections on the engines after 8,000 hours on naphthenic base Series III lubricant shows no stuck rings and no scoring. The cleanliness of the ports were improved over those for a straight mineral oil.

Four-Cycle Engines

Since the four-cycle gas engine more nearly resembles the automotive engine, it has been standard practice to use high VI paraffinic mineral oils in the four-cycle gas engine. This was a logical choice and straight paraffinic mineral oils have given acceptable service in these engines. However, many four-cycle engines tend to build up hard dry carbon deposits in the compression ring groove bottoms. The compression groove sides and ring sides by contrast have relatively low carbon and varnish buildup. Because of this, the compression rings ride on

the carbon in the groove bottom but do not stick. Therefore, it is concluded that for these engines high compression groove deposits, while undesirable, are not as serious as with the two-cycle engines. On the other hand, these engines tend to build up sludge in the oil rings and oil ring grooves so that oil ring area deposits are more serious in these engines than with the two-cycle engines. This is not to say that under severe conditions compression rings do not stick. In some field engines not on test, stuck rings and carbon deposits have been observed which completely cover the top ring. The causes were poor maintenance, poor cooling, poor oil change and filter change practices. However, where reasonable control of the above factors is maintained, the control of oil ring groove area deposits is considered the major problem. With these viewpoints in mind the performance of the different oils in the four-cycle engines is discussed below.

When the straight mineral Oils A (paraffinic) and B (naphthenic) are tested in the four-cycle engines, they differ widely in performance. The hard type of deposits formed by the paraffinic Oil A, while not desirable, permits the engine to remain cleaner than it does with Oil B which deposits sludge in the engine and filters. The demerit ratings on these oils are shown below:

Four-Cycle Engines

Demerit Rating: 0 = Clean, 10 = Max. Deposit

Oil	Ring Zone	Overall Piston	Crankcase	Filter Plugging
A (Paraf. Base)	4.7	1.7	Clean	None
B (Napht. Base)	3.0	1.9	Sludgy	Mild

The soft, sludgy deposits of Oil B caused some oil ring plugging and some sludgy skirt varnish. Thus it would be unacceptable to many operators. It should be pointed out that Oil B, because of its inability to hold its products of oxidation in suspension, deposits these products in the engine and on the filter. The tests on the crankcase oil, as measured by neutralization value and viscosity increase, remain good. Some operators consider the softer carbon deposits of Oil B more desirable than the harder, cleaner-appearing deposits of Oil A and are willing to tolerate the disadvantages of Oil B.

In the four-cycle engine Oil E showed considerable improvement over Oil C. This was largely the result of improved detergency. With greater detergency the oil was able to hold the products of oxidation in suspension so that the engine crankcase, filters, and pistons were kept much cleaner. These points are illustrated below:

Four-Cycle Engines

Demerit Rating: 0 = Clean, 10 = Max. Deposit

Oil	Ring Zone	Overall Piston	Crankcase	Filter Plugging
A (Napht. Base Mildly Det.)	2.5	1.5	Sludgy	Mild
E (Napht. Base MIL-L-2104A)	1.8	1.1	No Sludge	None

An interesting point with Oil E was that the viscosity increase and neutralization values were higher than with Oil C, again reflecting the fact that the detergent held the products of oxidation in suspension. The carbon deposits left by Oils C and E were much softer than those ordinarily obtained in the four-cycle engine with the straight paraffinic mineral oil. These softer type deposits are preferred by most plant operators. In plants where both two-cycle and four-cycle engines are used, the performance of the naphthenic detergent oils in both type engines means that only one grade of oil need be carried. This aids in plant lubrication simplification.

Tests are now in progress on oils of Type D with several additive combinations. Excellent results have been obtained to date. These studies are being continued.

The performance of Supplement I level oils (Oil F) has shown that these oils would permit the operation of engines for long periods of time without dangerous deposit buildup. Very low ring zone deposits and overall piston deposits have been obtained on these engines with over 12,000 operating hours. These tests are being continued for extended periods.

The use of a naphthenic base oil of Series III level (Oil G) is now being investigated in four-cycle engines. Present indications are that the performance will be excellent. It is believed that oils of this quality level would not be necessary except where operations are severe. However, it is our belief that the periods between overhauls can be extended if these oils are used and each operator should compare the added cost of the oil with the reduced overhaul costs over an extended period. In some situations the extra cost of the oil is amply justified.

Although it is not the purpose of this paper to discuss additives of the inhibitor type, it may be well to point out that extensive studies of experimental oils containing various oxidation inhibitors have been made. These studies show that regardless of the results of laboratory screening tests, gas engines, because of the conditions under which they operate, are very sensitive to many inhibitors. Thus the use of the wrong oxidation inhibitor or the excessive use of inhibitor may result in actually harming the performance of the oil. Inhibited oils, therefore, should be used only on the advice of the oil supplier.

Used Oil Tests

One of the more important criteria of a gas engine lubricant is the ability of the oil to resist oxidation and sludging in the crankcase. The oxidation of oils in the crankcase is not clearly understood and may take many forms depending on oil types, engine types, filters, engine conditions and oil addition rates. The results of oxidation may be reflected in sludge, high viscosity increases, high acid numbers, piston underhead deposits and high piston deposits. Many factors affect the condition of the crankcase oil. Among these are: (1) oil addition rate, (2) oil drain periods, (3) the condition of the rings, pistons and cylinders of the engines, (4) filter change periods.

In engines with poor oil rings and poor compression rings, much evidence of soot and carbon from blow-by gases may be seen in the crankcase. Since the blow-by gases from even a clean burning fuel like natural gas may contain formaldehyde, acrolein, water, and a number of other compounds of unknown structure, these gases probably have a marked effect on the crankcase oil.

Since all tests on used oils are influenced to a degree by the mere factor of new oil dilution, the oil addition rate has a marked effect on the tests. The effect of filter change period and the relation of the time of filter change versus the time of sampling has an effect on the used oil tests.

As discussed under the general heading of two-cycle engines, the effects of gases from the combustion zone are essentially nil and the crankcase oil remains practically unchanged from year to year. However, since the crankcase oil does pick up some dirt, metal particles, etc., the oil should be checked periodically. Proper filtration should keep the oil satisfactorily clean from one overhaul period to the next.

In the four-cycle engine several generalizations can be made. These are listed below:

(1) The non-additive naphthenic base oils show filter sludging tendencies, low neutralization value increases, and low viscosity increases.

(2) The non-additive paraffinic base oils show lower filter sludging tendencies, relatively high neutralization value increases, and high viscosity increases.

(3) The all-naphthenic base oils with detergent additives show properties more nearly similar to the paraffinic base oils in that the filter sludging becomes less while neutralization values and viscosities increase.

(4) The cleanliness of the crankcase and power cylinders and performance of the oil in general are not shown by any of the conventional used oil tests employed.

The fact that naphthenic base oils in four-cycle engines tend to deposit sludge in both the crankcase and filter and to show low neutralization value and viscosity increases is believed to occur because this oil is unable to keep the products of oxidation in solution and thus deposits them on the filter and throughout the engine. This makes for a dirty-appearing engine and although the deposits are somewhat soft, the quantity and appearance are objectionable. The used oil tests meanwhile would have looked "good". It is of interest that with all of the oils tested in the four-cycle engines, there was a poor correlation between ASTM Saponification Number and Neutralization Number, and between Neutranization Number and Viscosity Increase.

The use of various detergent additives in gas engine lubricants has shown little effect on the used oil tests except that the use of sufficient detergent additive in naphthenic base oils to control sludge has resulted in the oils showing essentially the same oxidation pattern as the paraffinic detergent oils. In general, it is concluded that the oil and filter change practices, based on used oils inspections, need to be critically reviewed to ascertain whether uneconomical measures are being followed.

Accordingly, studies were made when the oil change periods were shortened to 2,000 hours. In view of the relatively rapid oil changes the filter change periods were lengthened from 720 hours to 2,000 hours to coincide with the oil changes. With this procedure, the engine conditions and engine cleanliness were markedly improved over those engines using 750 hours filter changes and 3,000 hour oil changes. When the cleanliness level of the two engines are compared on the basis of lengthened periods between overhauls, it is believed that the engine with the more frequent drain periods would have run at least 50 per cent longer before an overhaul was desirable.

A comparison of only the oil and filter costs for 8,000 hours for the two cases are listed in the following table.

Case	I	II
Crankcase Drain Period, Hrs.	8,000	2,000
Filter Change Period, Hrs.	750	2,000
Oil Used, Gallons		
Crankcase Changes	250	1,000
Filter Changes	400	160
Total	650	1,160
Filter Costs	$375.00	$150.00
Oil Costs	227.50	406.00
Total Annual Cost	$602.50	$556.00

The foregoing figures do not take into account the labor costs for changing oil and filters but where adequate pumpout facilities are provided for changing oil the costs for the two cases are probably slightly in favor of Case II. When the costs of labor, parts, and downtime are calculated for an engine overhaul, it is apparent that extra oil costs are of minor consideration in the overall costs of engine operation.

Extended test runs are now being made to demonstrate the economic advantages of frequent oil changes. Each operator should study his own particular plant situation in order to arrive at oil drain practices that will result in the greatest economic savings to him.

SUMMARY

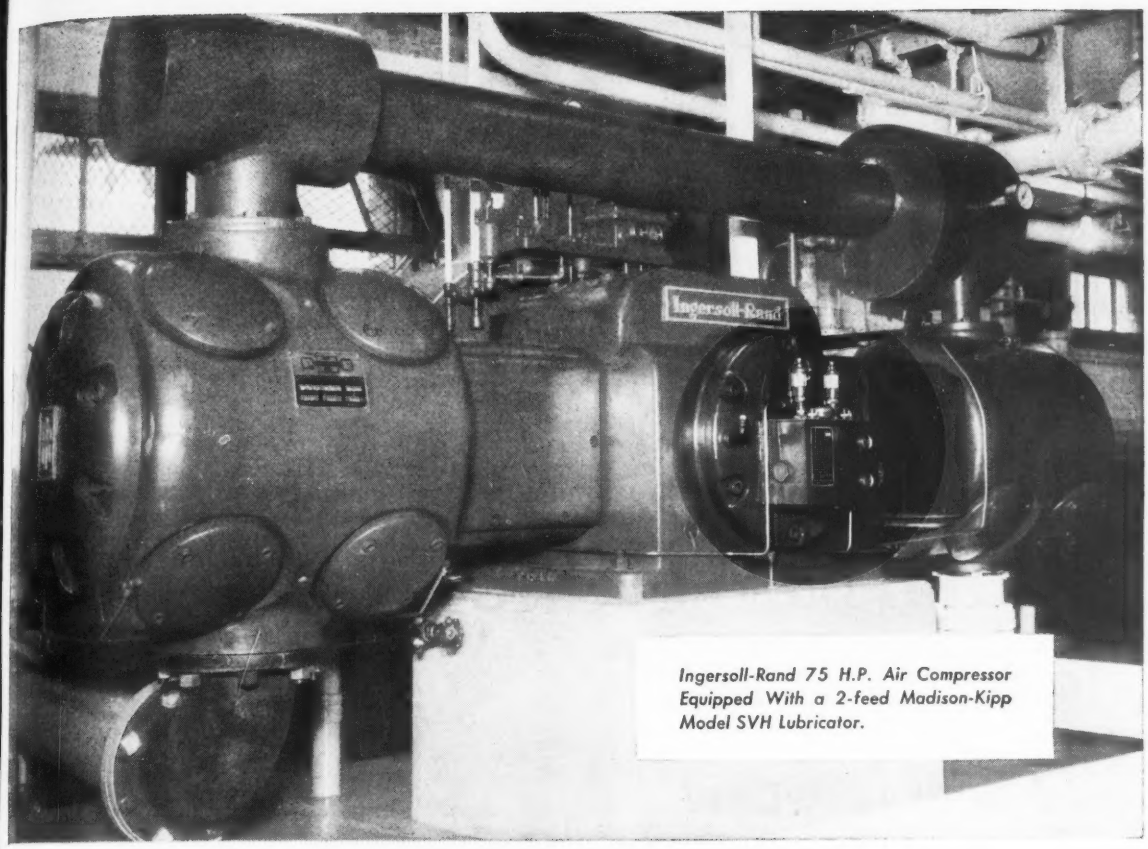
1. Where gas engines are kept clean through the use of good oil and good maintenance, wear is not a problem.

2. In the two-cycle engine in mild service, non-detergent naphthenic oils are superior to non-detergent paraffinic oils. As the severity of service increases the use of detergent, naphthenic base oils are indicated for maximum cleanliness.

3. In the four-cycle engine the non-detergent paraffinic base oils are superior to the non-detergent naphthenic base oils. As the detergency levels of the two types of oils are increased, their performance becomes more nearly equivalent so that at MIL-L-2104A levels of detergency or higher, either oil may be used in the four-cycle engine.

4. The introduction of the new high output turbocharged four-cycle engines may require special lubricants. Because these engines are new, our field experience does not permit us to thoroughly define the lubrication requirements. This problem is being actively pursued.

5. Used oil tests such as neutralization number and viscosity increase show little correlation with engine cleanliness. Oil drain and filter change periods should be made on the basis of operating experience which will show what periods will provide the best engine cleanliness. The choice of oils of the correct base stock and detergency level for each installation will permit the operation of the engines for longer periods of time without overhaul. Wear rates will be kept to a minimum. Maximum power output will be obtained because of free acting rings. Safe operations under severe conditions will be maintained. Each operator should avail himself of these advantages of modern lube oil technology.



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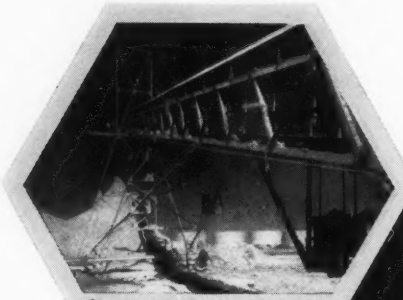
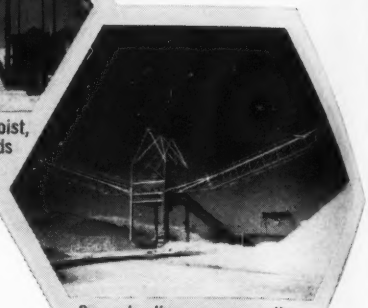


Conveyor-stacker handling moist, sticky material which builds up on the rollers.



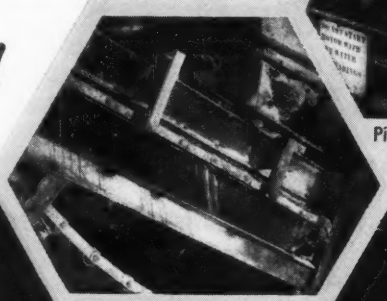
Ore unloading conveyor rollers handling 200 tons of ore per hour.

THE PROOF IS IN THE PERFORMANCE...

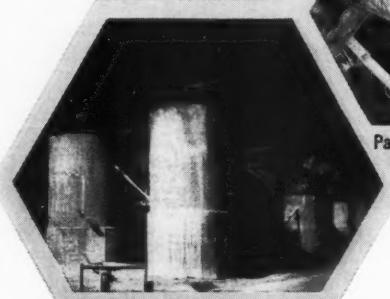
lithium-base grease does the job...

and does it better!

Pinion gear transmitting power from 600 h.p. motor to a ball mill.



Pan Conveyor handling hot clinker (1600°F), roller bearings in dusty, moist atmosphere.



Leach tanks handling hot slurry, agitators driven by Falk gear reducing units.

V.A. Wemco classifier, part of wet grinding system, lower bearing submerged in hot sludge.

Here's a report of our own experience with lithium-base grease under extreme industrial service conditions. Approximately 95% of the grease used in the plant of AMERICAN LITHIUM CHEMICALS, Inc., our subsidiary at San Antonio, Texas, is lithium-base, one-type grease. In fourteen months operation we have not been able to trace a single cause for bearing failure to the lubricant used. The on-the-spot photos above give graphic evidence of the rugged bearing service requirements in this plant where lithium ores are processed into high-grade lithium hydroxide, itself an important ingredient in lithium-base grease. Performance like this is why grease chemists, manufacturers, marketers and users all attest to the superiority of lithium-base... the *one* grease in place of *many* for efficient and economical operation.

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Section News

Houston—Thirty members and guests attended Nov. 4 meeting in the Ben Milam Hotel. Frank G. Binger, Chicago Tool Co., spoke on "Care, Lubrication and Maintenance of Chicago Pneumatic Air Compressors and their Drives."

New York—R. J. Ronan, regional manager of Texas Co.'s Technical Services Division was heard on "The Role of the Analytical and Testing Laboratory in Lubrication Practice" at a well-attended social hour and dinner meeting (Nov. 14). Also heard was B. T. Schleicher of the Black Bear Co. He gave some answers to the significant question "What Happened to Our Hydraulic System?".

Chicago—R. O. Kageff, Ford Motor Co., was the featured speaker on Nov. 21. His paper, on "Standardization of Plant Lubricants and Lubrication Practices", covered simplification of lubricants, education of personnel, preventive maintenance, automatic lubrication systems, and specifications, and described a successful program put into effect at many Ford divisions.

Buffalo-Rochester—Sections held joint dinner meeting (Nov. 20) . . . General Motors' Carl Goodzeit spoke on "The New Theory and Practice of Bearing Materials . . . both groups were well represented.

Puget Sound—E. J. Gesdorf, senior application engineer at Farval, continued his speaking tour of the West Coast sections.

The Lubrication Engineering profession has lost one of its most valued members.

Dr. Roger H. Decker, 38, past chairman of the Northern California ASLE Section, died on September 12. A graduate of Massachusetts State College and Iowa State College, he received his Ph.D. in Organic Chemistry from Washington State College in 1948. Dr. Decker began his teaching career as a graduate chemistry assistant at Iowa State, later became a Teaching Fellow in Chemistry and physics instructor at Washington State. He was employed by the Socony-Vacuum Co. at Paulsboro, N. J. in their research and development labs until 1947 when he began work as senior research chemist with the Tidewater Oil Co. at Avon, California. In addition to his ASLE membership, Dr. Decker belonged to AIChE and ACS.

A New Booklet:

"Industrial Dermatoses - - Protection, Prevention, and Treatment"

Donald J. Birmingham, M.D.; Dr. W. C. Witham; Leonard F. Weber; Nobel H. Schell; M. L. Beardslee; John M. Shaw, M.D.; E. A. Irwin, M.D., C. S. Livingood, M.D.

Eight experts in the field of industrial dermatitis assemble for the first time their experience and investigations in an ASLE-sponsored effort to curb these costly diseases. More than 100 million dollars in manhours are lost to American industry annually as a direct result of one or more forms of industrial dermatitis.

Five medical practitioners, a chemist, and lubrication and resident engineers examine the use and handling of cutting oils, lubricants, and solvent; and discuss protective measures in terms of ointments, housekeeping, and prevention of bacterial decomposition. While no blanket solution is agreed upon, one of the many measures outlined here may prove a solution to your specific plant problem. An informative panel discussion among all participants concludes the booklet.

Mail the coupon below for your copy.

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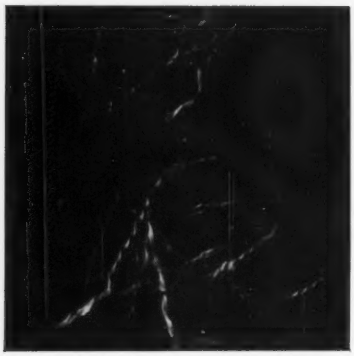

1μ

Micrograph showing soap structure of lithium base lubricating grease made from 12-hydroxy stearic acid. Courtesy of Sinclair Research Laboratories, Inc.

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- Eliminates abnormal wear
- Soap oxidation stability
- Cold operating properties
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- Mechanically and chemically stable

IN APPLICATION

- Prepacking anti-friction bearings
- Lubrication of plain and anti-friction rotating bearings
- Lubrication of vehicle chassis points, wheel bearings, universal joints and water pump
- Lubrication of high-temperature ball bearings
- Aircraft, artillery, instrument and general ordnance maintenance

IN MARKETING

- Lower inventory
- Less dispensing equipment
- No chance for misapplication
- Reduction in lubricating time
- One grease lubricates a vehicle

IN INDUSTRY

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- Transportation
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ASLE News Notebook

Compiled by
R. D. McCormick

Executive Reports

A recommendation has been prepared by the Regional Vice-Presidents pertaining to the duties of Section Officers. In a statement before the Board at their meeting of October 8, 1957 the action of these duties were defined as follows, "The presentation pertaining to the *Duties of Section Officers* shall be considered as recommended practices and not binding. The incorporation of the recommended practices relating to *Duties of Section Officers* into Section By-Laws shall be passed upon by the Regional Vice-Presidents."

The Executive Committee recommended to the Board of Directors that the June Board of Directors meeting be eliminated in order to reduce expenses and additional workloads on the National Office, since the meeting occurs only a few weeks after the Annual Meeting of the Society. To accomplish this, the old Board of Directors would meet the day prior to the start of the Annual Meeting providing reports pertinent to the previous year's activities and operations. A second meeting of the Board would be held on the last day of the Annual Meeting to carry on business for the new year and to elect the Nominations Committee.

EASTERN

Mr. M. E. Dougherty reported on the 11 Sections in the Eastern region. Total membership in the region is 1086 as of September 30, 1957, and anticipated membership at the end of the 1957-58 year should total 1300. A new Section at Rochester, N. Y. has been chartered and possible new Sections in the Erie, Pa.; Huntington-Charleston, W. Va.; and Richmond, Va. areas are being considered. Eight of the Sections are planning educational courses and eight have planned membership drives. Five Sections have been visited in the past period.

MIDWESTERN

Two new Sections are planned for the midwest region in the immediate future. One Section will be located in the Quad Cities region centered at Davenport, Iowa, and the second in the Dallas-Ft. Worth, Texas area. One meeting has been held in the Quad Cities area.

Membership increase forecast for Sections in the midwestern region should total 207 additional including 50 new members from the two new Sections.

A Joint Automotive Lubrication Conference, consisting of six papers to be presented during an all-day meeting March 11, 1958, is being cosponsored by the Chicago Sections of the Society of Automotive Engineers and the ASLE.

WESTERN

San Francisco, Los Angeles, and the Intermountain Sections have been meeting since September. Puget Sound held its first meeting in November. A proposed new Section in the San Diego area held its organization meeting in October. (No further information was available at the time of publication.) In view of the difficulties of financing new Section activities a greater rebate was suggested by the executive committees of the Sections in the Western Region.

CANADIAN

Membership committees have been organized for both of the Canadian Sections. Both Sections are using mail contact to key individuals in industry to invite attendance at a Section meeting. Personal follow-ups with the prospect will be made to obtain membership application. Neither Section has plans for an educational program during the 1957-58 period. Membership drives in Canadian Sections should net a 25 percent increase in the next period. *(Continued on p. 651)*

British West Indies' Application Engineer Is 3000th Member

K. M. DE SOUZA

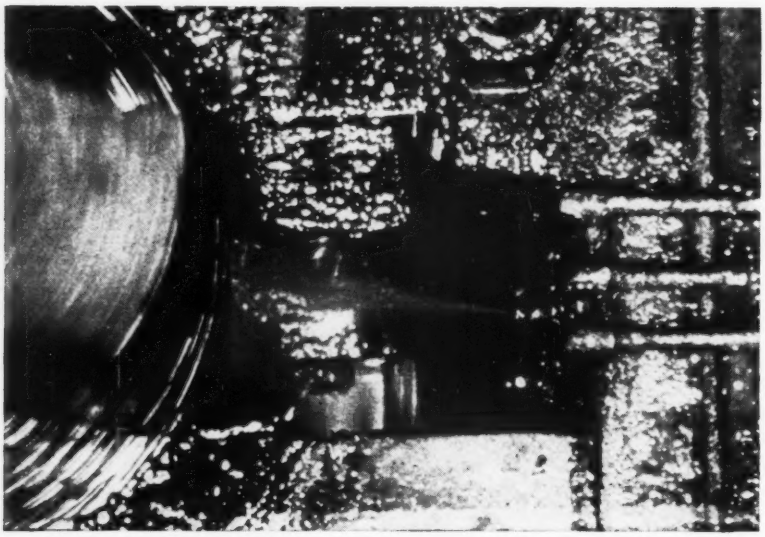
Welcome is extended to the 3000th member of ASLE, Mr. K. M. de Souza of Esso Standard Oil, S.A., Trinidad, British West Indies. Recently returned from a six-week sales training course, Mr. Souza will provide lubrication engineering services to oil producers and refineries, the sugar industry and other industrial operations in the West Indies.

Born in Georgetown, British Colombia, Mr. de Souza attended St. Stanislaws College in Georgetown. He was introduced to the Society and its goals by Mr. M. M. Gurgo of the New York Section. Lubrication Engineering is proud to welcome Mr. de Souza to the Society.

THE BROOKS OIL CO.

Lub Engineering News

A REPORT ON THE DIFFICULT LUBRICATING PROBLEMS OF INDUSTRY



SPRAY LUBRICATION OF ROLL NECK BEARINGS CUTS COSTS FIVE WAYS, STEEL MILL REPORTS

Lubrication of roll necks and bearings by means of a spray system employing a fluid lubricant, as shown in the unretouched photograph above, has proved far superior to the traditional system of forcing grease along grooves machined in the bearing surfaces, according to reports of an extended study recently completed by a major steel company.

Five major savings resulted from the use of the spray system:

1. The initial cost of preparing the bearings for service was reduced because it was not necessary to cut grease grooves. Also, the safe overall bearing area is substantially increased.
2. Lubricant consumption dropped from an average of 20 drums per week to approximately 3 drums.
3. Bearing life was substantially increased. With the old system of lubrication, bearings wore out in about 3 weeks. Bearings lubricated by the spray system showed no appreciable wear after 18 weeks of service.
4. Longer bearing and roll neck life also meant less time and cost for remachining and dressing.
5. Mill downtime was greatly reduced. With ordinary lubrication, 5 intervals of downtime would have been expected during the four months of the study period—with spray lubrication there was *no* downtime—saving thousands of dollars.

First adapted in 1949 and now being used by major steel companies for this important and severe application—the lubricant was Brook's Klingfast, a lead base fluid lubricant which retains its film strength (4 gram Timken test, 30 min. minimum—43 lbs. L.A.L.).

For complete data, write for Bulletin K-26-LE.

NEW COLOR FILM GIVES ANSWERS TO TOUGH LUBRICATION JOBS

Want to see how good lubricants get that way—lubricants for severe industrial applications, that is?

This new 30 minute 16 mm motion picture, in full color, with sound, shows a number of tough lubrication jobs. It pictures and describes the research, manufacturing and quality control methods that enable Brooks lubricants to "stand up" under severest service

It's available to any supervisory or engineering group interested in lubrication problems. No charge, of course—we're glad to have you see it. Just call or write any of our offices and tell them you want to borrow "The Brooks Oil Story."

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Committee Reports

By-Laws

The committee has been active during the summer rewriting the constitution and by-laws of the Society based upon ASLE activities and their interpretation during the past seven years. Appointment of an official parliamentarian has been suggested by the committee to advise the Board of Directors upon Board actions and the by-law bearing upon the action and its interpretation.

Joint Conference

Activities of the committee resulted in a very fine program presented at the 4th Annual Conference in Toronto, Canada. A reporter technique was used to provide information about the papers from the Institute of Mechanical Engineers meeting in London, England. This, plus holding the meeting in Canada, has given the Conference a truly international flavor. Board action on appointment of a conference treasurer, a means of providing funds for committee use prior to the conference, and a policy regarding social functions at the conference have been requested. Chicago has been selected as site for the 1960 conference; the 1958 conference will be held in Los Angeles and the 1959 conference will be in New York. Appointments to the 1958 Conference Committee for the ASLE are: A. C. West (Vice-Chairman), A. Hundere, E. G. Jackson, and R. L. Johnson.

Finance Committee

Meeting monthly, the Finance Committee is continually reviewing the expenditures and financial problems of the Society. A summary report of the committees' recommendations for the budget for the Society is being prepared for the next meeting of the Board.

Nominations

Letters to each of the officers, directors, and Section chairmen were sent in September. Suggestions for nominees for the elective offices are being screened by the committee and will be reported to the Board at the January meeting.

Tellers

The Tellers Committee has been appointed and will be assembled to count ballots at the appropriate time.

Membership and Admissions

Total membership as of September 30, 1957 was 2,959. Compared with the total April 30 of 2,828 a net-increase of 121 members has been obtained. Prior to the April tally, 307 members were dropped for nonpayment of dues, resignations, or deaths. Although the increase in membership is not encouraging it has come during the period of least Section activity. A national competition for new members has been established by Mr. B. M. Dunham, National Membership Committee Chairman, with each Section competing for total increase based upon three divisions by Section size. Education course work as a promising method of membership growth is being stressed.

New Sections

Reports of new Section activities has been shown under the reports of the Regional Vice-Presidents.

Industrial Membership

A proposal to rebate a portion of membership dues collected from Industrial members to the Section bounding such membership is being investigated. The investigation has not been completed and will be reported on in the future.

Abstracts

Abstracts subcommittee chairman for each of the technical committees except Hydraulics and Lubrication Equipment have been appointed and are functioning. Since the January issue of *Lubrication Engineering* 54 abstracts have been published.

Editorial

A meeting of the newly organized Publications Committee was held September 12, 1957 at Pittsburgh. The committee agreed to follow the Finance Committee recommendations for minimizing publication costs for the journal for the balance of 1957. Approximately 60 papers are available for editorial review by the Editorial Review Committee.

National Program

Fifty percent of the committee's goal for the 1958 Annual Meeting has been met with 39 papers committed for the meeting. Seventy-five are planned and tentative commitments have been made for 51. The program will be made up of three 2-paper sessions and fifteen 3-paper sessions held concurrently as in past years.

ASLE Preprints Available

The following preprints of papers presented at the ASLE-ASME 1957 Lubrication Conference are available at 35c each to members, 50c each to non-members. To order, indicate the number of copies desired, fill in your name and address, enclose remittance, and mail to:

ASLE, 84 E. Randolph St., Chicago 1, Ill.

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_____(57LC-2) *A Study of the Effect of Wear Particles and Adhesive Wear at High-Contact Pressure*, by E. B. Sciulli and G. M. Robinson.
_____(57LC-3) *Chrome Face vs Iron Side Wear—An Analysis of Some Radioactive Piston-Ring Wear Studies*, by R. G. Abowd, Jr.
_____(57LC-4) *The Role of Atmospheric Oxidation in High-Speed Sliding Phenomena*, by M. Cocks.
_____(57LC-5) *A Theory of Cutting-Tool Wear and Cutting-Oil Action*, by A. Dorinson.
_____(57LC-6) *Boundary Lubrication, Wear-In, and Hydrodynamic Behavior of Bearings for Liquid Metals and Other Fluids*, by L. F. Coffin, Jr.
_____(57LC-7) *Solid Film Lubricants at High Temperatures*, by E. P. Kingsbury.
_____(57LC-8) *Investigation of Factors Governing Fatigue Life with the Rolling Contact Fatigue Spin Rig*, by T. L. Carter, R. H. Butler, H. R. Bear, and W. J. Anderson.
_____(57LC-9) *The Effect of Aircraft Gas Turbine Oils on Roller Bearing Fatigue Life*, by M. E. Otterbein.
_____(57LC-10) *The Effect of Lubricants on Gear-Tooth Fatigue*, by T. F. Davidson.
_____(57LC-11) *The Determination of Flow, Film Thickness, and Load Carrying Capacity of Hydrostatic Bearings Through the Use of the Electric Analog Field Plotter*, by A. M. Loeb.
_____(57LC-12) *A Solution for the Finite Journal Bearing and its Application to Analyses and Design—III*, by A. A. Raimondi and John Boyd.

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Lubrication Standards

(Continued from p. 632)

2. Flexible lines shall be restrained or confined if their failure is a hazard to personnel.
3. Personnel shall not be required to reach past revolving spindles, moving tools or equipment to reach manual controls.

There are, however, other items in the writing which are also concerned with safety. These require that lubrication fittings, devices, pumps and reservoirs be accessible so as to eliminate the hazards of using temporary ladders, climbing on the machine or equipment, removing covers or guards or getting into a hazardous position in attempting to reach a poorly located point.

In the interest of achieving increased machine output, the standards aim at obtaining lubrication provisions which will permit servicing without the necessity of stopping the machine and by making possible better lubrication of the equipment.

This is accomplished by requiring that lubrication points be located on stationary parts of the equipment; that centralized lubrication be used; that lubricant reservoirs be provided with level indicators which show visually where the level should be when the equipment is running as well as the usual high and low levels; that these reservoirs be arranged for filling during operation and that transparent bowl air line lubricators be such that they can be filled without shutting off the air.

There are many ways of improving machine life, one of which is improved lubrication practices. The above points contribute to this end by making possible lubrication of the machine as it is required, rather than only when the machine is not running. The following covers other aspects of proper lubrication.

Positive lubrication must be provided, but where overlubrication or excessive lubricant pressure could be detrimental, preventive steps must be taken. Intermixing of other fluids in the machine with the lubricants must be avoided. Lubrication diagrams, charts and data sheets should be used to convey the information necessary to service the equipment properly. Lubrication points must be accessible to assure that necessary lubrication can be applied easily. Different fittings must be used for grease and oil to prevent introducing the wrong type of lubricant.

Centralized lubrication systems should be used and must be properly installed and adjusted. While precautions must be taken to prevent contamination of the lubricants, filtration should be provided where detrimental contaminants are to be expected during normal operations. Such filters must be arranged for easy cleaning or replacing so that they will not become ineffective because of inconvenient servicing. Cap type closures for lubricant reservoir fillers should be used to reduce contamination by eliminating dirt and chips which accumulate around the threads of plugs.

Housekeeping may sound out of place when applied to an industrial plant, but it is receiving more and more attention. Bright colors are being employed today where dark gray was formerly used to paint machines. Excessive lubricants or leakage because of poor design or choice of machine components intended to retain or control lubricants is much more noticeable on pastel colors and light tile flooring.

Here again, accessibility plays an important part because less lubricant is liable to end up outside of the oil cup or grease fitting if it can be easily serviced. Oil reservoirs must be arranged for draining and cleaning without spilling and must be large enough to retain all lubricant that will drain back. The level indicator should show the levels noted before and should be located in such a position that it can be observed while the lubricant is being added so as to prevent over-filling.

Much of the standardization of lubrication equipment and methods is left up to the purchaser's preference, but there are certain items of sufficiently wide acceptance to be included in the standards.

National pipe thread sizes must be used for tapped holes for installing lubrication devices or lines. This alone will help greatly in reducing the variety of devices which may come into a plant and will also facilitate alterations and the addition or extension of lubrication systems.

Hydraulic type grease fittings are limited to the application of grease only and will contribute to the reduction of the number of different fittings as well as eliminating the mixing of lubricants when such fittings are provided for oil lubrication.

Air line lubricators having a visible oil level must be used; a small thing, but a great time saver.

CONCLUSION

These standards are a step toward improved and simplified lubrication of industrial equipment. Even now revisions are being considered and as smaller problems come to the forefront, further changes will become desirable. The end result will be improved lubrication.

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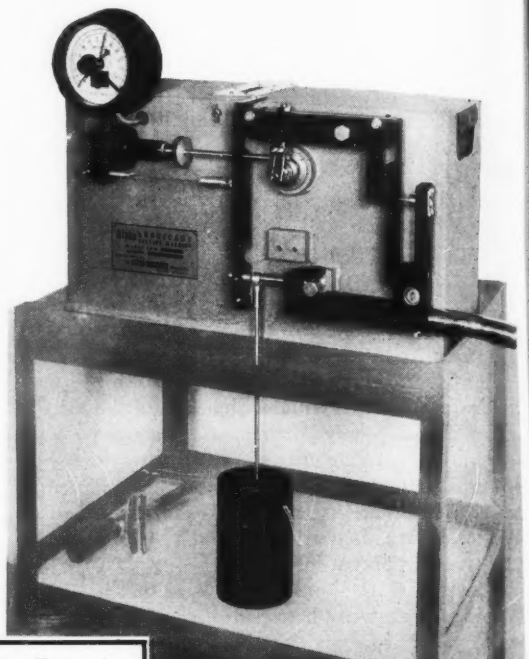

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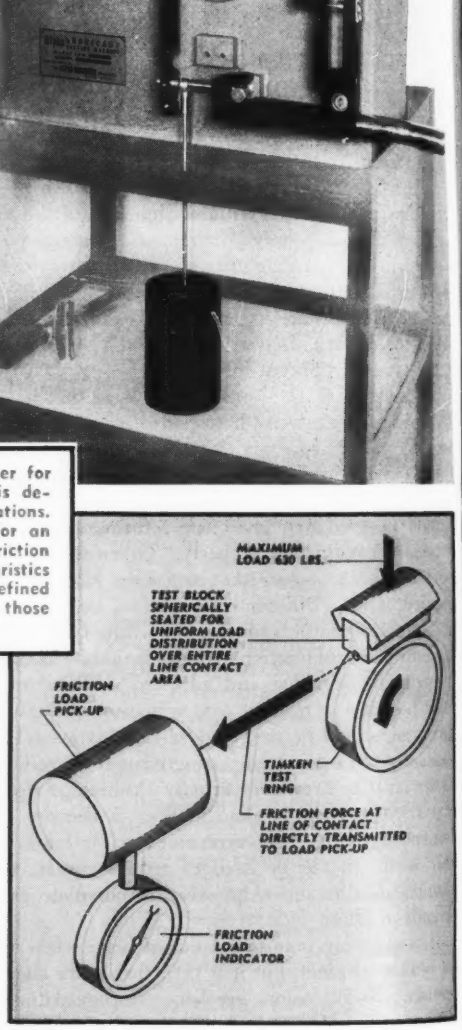
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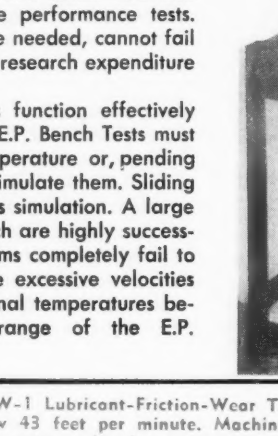

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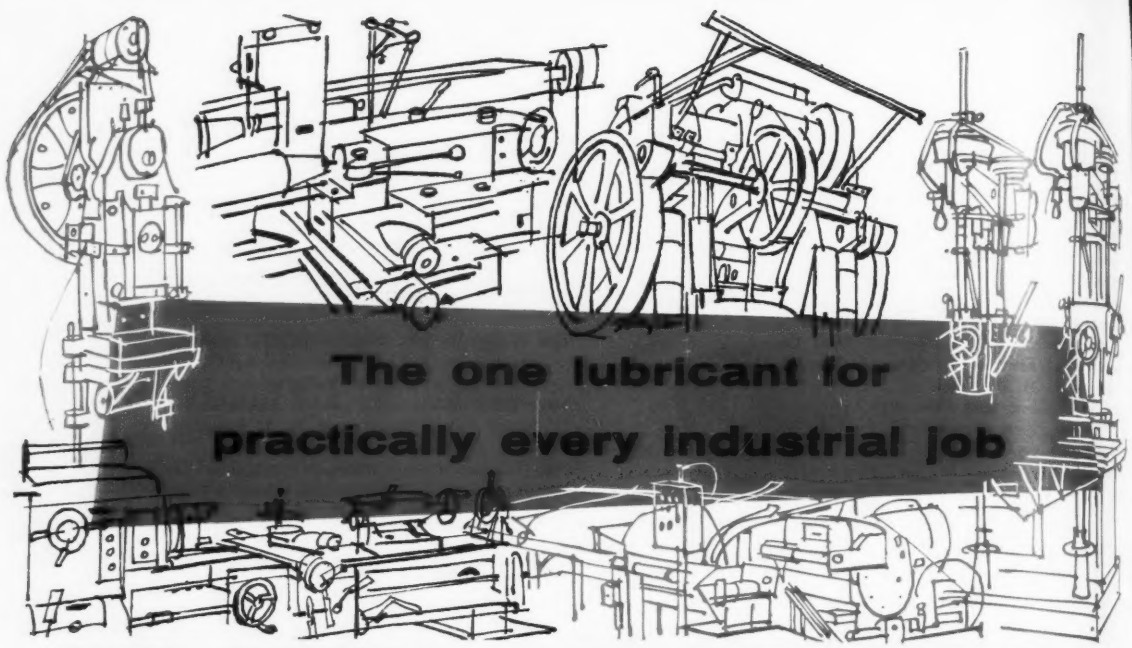

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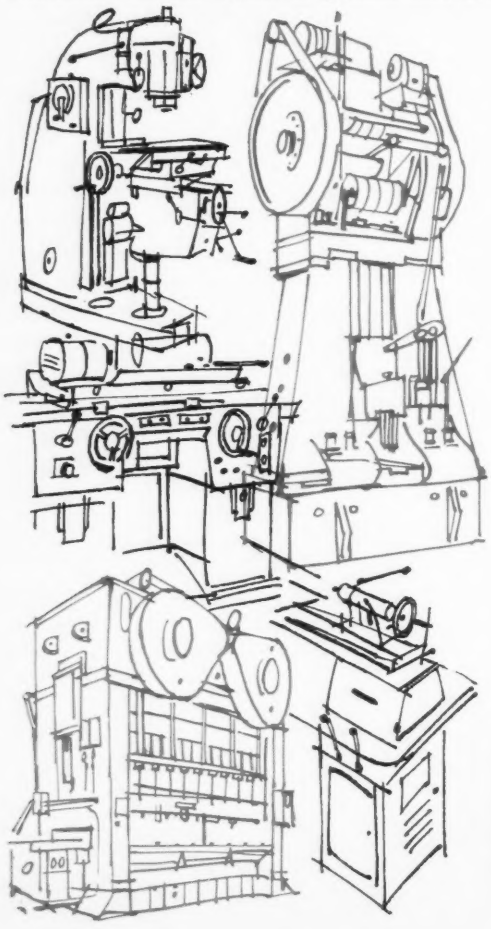

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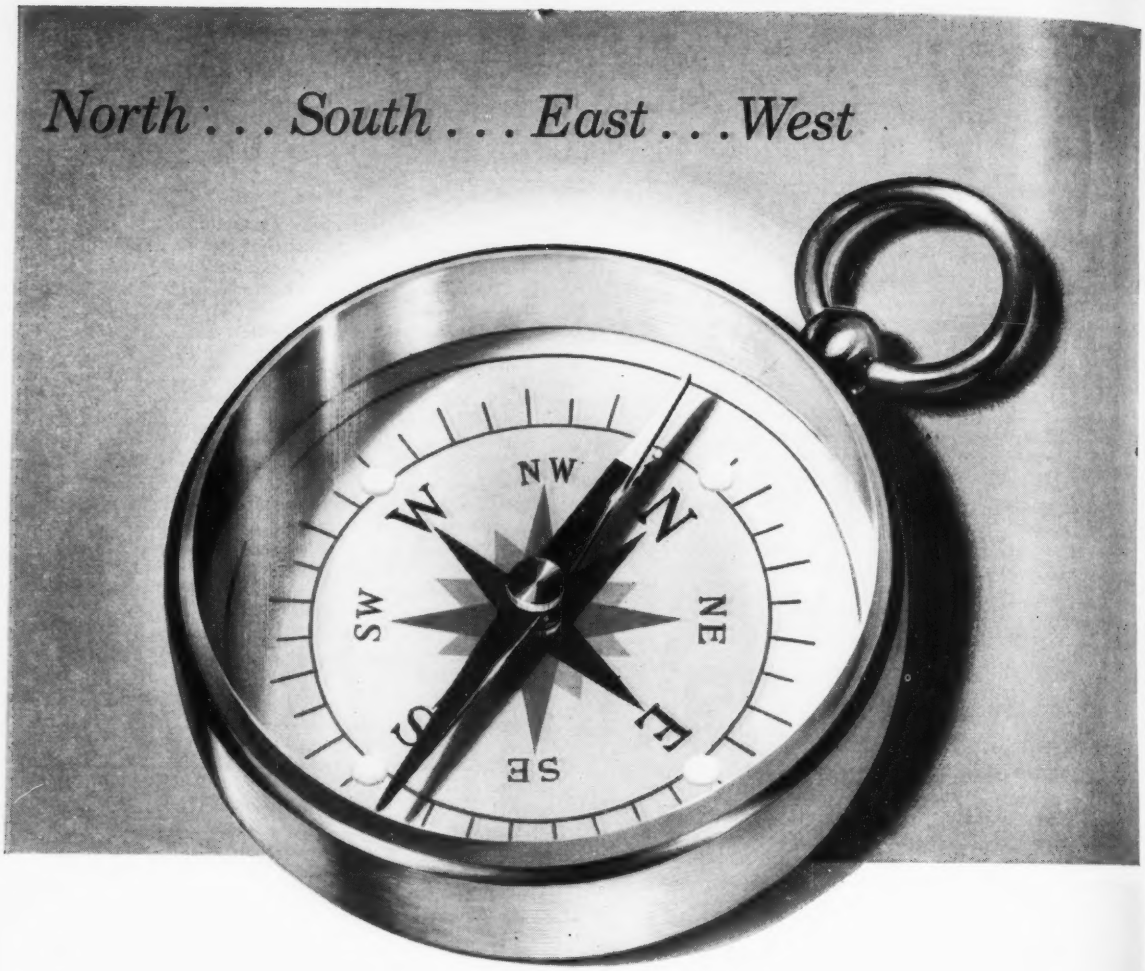

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(Continued from p. 646)

Unfortunately, however, most case histories are discussed only in very general terms. Lack of information concerning the type of grease previously employed, the respective lubrication periods, or other quantitative performance data precludes an objective appraisal of overall performance level. Such additional information would enhance the value of this interesting and stimulating paper.

AUTHOR'S CLOSURE

As indicated in the abstract, the paper attempted to outline the performance of terephthalamate grease in terms of required characteristics for various types of service, and the limiting environmental conditions imposed by each service. Any direct comparison with specific greases was most carefully avoided because it is difficult to describe most greases by type without also naming them.

Obviously, one of the desired goals of a multipurpose grease is to simplify the line of products required to lubricate adequately a customer's plant. If the grease is successful, replacement of conventional calcium and sodium base greases can be achieved. If the same grease can also successfully compete with multipurpose greases of other manufacturers, it must be equal or superior to them in most performance aspects. In this event, lithium base greases would most certainly be replaced. As the concluding sentence of the paper indicates, "it (terephthalamate grease) has displaced nearly every other type of grease now manufactured."

Lubrication periods, where significant, were mentioned, as in the case of the mine car wheels submerged in water. Quantitative performance data are difficult to obtain in industrial grease service tests because identical multiple units are not generally available. In the steel mill annealing oven fan bearings, quantitative test results were possible and are mentioned in the paper.

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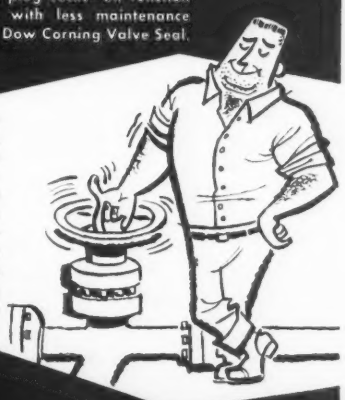
Plug valves, control valves, flow meter bearings, pump packings, plug cocks—all function more efficiently and with less maintenance when lubricated with Dow Corning Valve Seal.

A nonmelting, grease-like silicone compound, Valve Seal retains its lubricating effectiveness at temperatures from —40° to 500°F. Resists moisture, oxidation, many chemicals and gases. Eliminates the need for stocking a variety of special purpose valve lubricants.



Send for FREE SAMPLE and full information.

First in Silicones

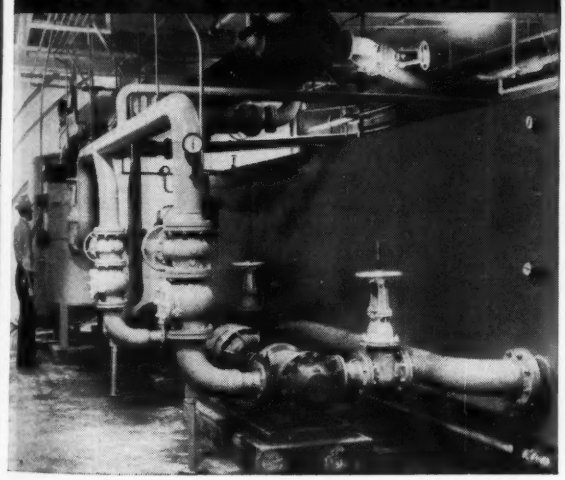
DOW CORNING SILICONES

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

DEPT. 6724

DRAVO-DELAVAL lubrication and coolant systems

Engineered Protection for Rolling Mill Machinery



Dravo-DeLaval Lubrication and Coolant systems are designed to circulate the right amount of lubricant at the right pressure and temperature to the right spot. Dravo Lubrication systems include these four fundamentals essential to efficient mill lubrication:

Streamline Flow

Piping, elbows and valves are carefully selected to hold pressure drops to a minimum and to provide non-turbulent flow.

Correct Metering of Lubricant

Dravo systems are designed to supply the right amount of lubricant needed at each lubrication point.

Temperature Control

Accurate, automatic temperature control is a feature of every Dravo system.

Efficient Filtering

Full flow, pressure type filters allow an uninterrupted flow of clean lubricant with minimum pressure drop.

Dravo-DeLaval systems are custom designed to match customer requirements. For installations requiring up to 50 gpm, Dravo-DeLaval Unilube units offer compact, economical "packaged" lubrication systems. For complete details, write Dravo Corporation, Dravo Building, Pittsburgh 22, Pennsylvania.

DRAVO CORPORATION

Special Lubrication and Coolant Systems for mechanical equipment serving industry

NEW...
EMERY 3033-S
LUBRICANT ESTER...

a new-type diester base for synthetic lubricants

Emery 3033-S is a new-type dipropylene glycol diester based on pelargonic acid, a unique, C_9, saturated, monobasic acid.

It is currently in use or under test in the following three areas: 1) Synthetic greases for spec. Mil-G-3278-A Low Temperature Aircraft Grease; 2) Low-cost blending component for synthetic low-temperature lubricating fluids meeting Mil-L-7808 C; and 3) synthetic lubricant base fluid for civilian lubricants in aircraft, automotive and specialty uses.

Since 3033-S is based on a relatively low-cost acid, pelargonic acid, long-range economics are favorable. Also, availability is not contingent on strategic, imported raw materials since pelargonic acid is made from abundantly available domestic fats and oils.

Though 3033-S is in a development stage, it is available in tankcar quantities on reasonable notice.

Mail coupon below for Technical Bulletin titled "Emery 3033-S Lubricant Ester" for complete characteristics and performance data in synthetic greases and fluids.

Dept. Y12-A Carew Tower
Emery Industries, Inc.
Cincinnati 2, Ohio

Please send Development Product Bulletin #60 on Emery 3033-S.

Name.....
Company.....
Address.....
City.....State.....

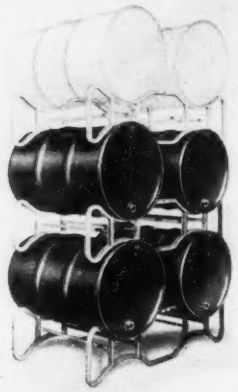
Emery

Development and Service Department
Emery Industries, Inc.
Carew Tower, Cincinnati 2, Ohio

New Products

BARREL RACK REPLACES SPECIAL HANDLING EQUIPMENT

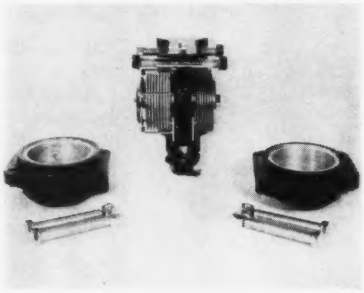
Development of a steel rack designed to permit handling and stacking of loaded or empty barrels and drums with standard



fork lift trucks has been announced by the Pressed Steel Division of Republic Steel. The new drum rack supports two loaded barrels and simplified the stacking of pairs of containers to any practical height. Great flexibility of handling and storage is said to be provided as individual drums or pairs of drums can be readily removed without excessive handling of the other drums in the stack. The barrel racks are made of heavy gage channel steel, strongly braced and welded. One unit will support 7,500 lb in 18 gage drums and 14,000 lb in 16 gage drums. Additional information is available in ADV Bulletin 961 from the Pressed Steel Division, Republic Steel Corp., 6100 Truscon Ave., Cleveland, Ohio.

BELLOWS-TYPE FLOW METER MEASURES OIL PRESSURES

A bellows-type flow meter accurate to within .005 percent and designed primarily for the oil and chemical industries has been



developed. According to the manufacturer's engineers, the differential pressure measuring device maintains this accuracy even when ambient temperature changes by as much as 100° F and static pressure reaches 2500 psi. In operation, differential pressure is applied to the bellows unit through high and low pressure connections. As the pressure changes, the liquid fill in the bellows unit moves from high to the low pressure side, or vice versa, changing the tension of the range spring. This moves the bellows connecting rod, repositioning the torque tube arm. The torque tube shaft is connected to the transmitter unit so that a change in differential pressure changes the transmitter output. Additional information is available from Minneapolis-Honeywell Regulator Co., 2954 Fourth Ave., Minneapolis 8, Minn.

CLEANER SAFE FOR SURFACES

A new liquid synthetic concentrate has been developed for cleaning equipment in refineries, chemical and gasoline plants and other heavy industrial installations. The concentrate, a blend of synthetic surfactants, coupling agents and sequestrian agents, is said to be harmless to paint and floor surfaces of all types as well as being safe in contact with personnel or clothing. No caustics, acids or harmful solvents are used in the concentrate. More details on "Seven-Eleven" concentrate are available from the Panther Chemical Co., 840 N. Main St., Fort Worth, Tex.

COMPOUND BONDS TO METAL

A tinning compound in powder form has been developed for tinning all metals prior to babbitting. The compound, AMCO No. 2679, forms a strong and permanent chemical bond with cast iron, steel and all metals used for bearings. When the babbitt metal is poured, it amalgamates with the tinned surface resulting in a strong and permanent bond between tinned surface and base metal, and babbitt metal and tinned surface. This double bond will reportedly hold the babbitt metal in place for the life of the bearing. For further information write American Solder & Flux Co., 19th & Willard Sts., Philadelphia 40, Pa.

STAINLESS STEEL SOLENOID

Control of high pressure corrosive gases and fluids can be achieved with a new two-way stainless steel solenoid valve. Rated to 6000 psi and designed for use with any media, the new valve is a direct lift type and is available in ⅛ in., ¼ in., ⅜ in. and ½ in. pipe sizes. Explosion-proof housings, bubble-tight construction, and teflon or nylon seats are available if desired. More detailed information will be found in Bulletin 2000 put out by Atkomatic Valve Co., 545 W. Abbott St., Indianapolis 25, Ind.